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ABSTRACT

In an attempt to demonstrate the direct relationship of physical play to sensory integration, this descriptive study measured fine and gross motor activities, and the repetition and duration of preferred activities among 179 children between 2 and 8 years of age who participated in 3 early childhood programs in California. Data were collected by means of videotape recordings, a sensorimotor checklist, and time samples. It was hypothesized that if children were provided ample time and a quality play curriculum, they would experience sensory integration in spontaneous play, and would seek out and repeat preferred activities. An extensive review of literature covered the topics of the ontogeny of sensory integration, sensory integration and the brain, play, quality play curriculum, sensory integration dysfunction, sensory integration therapy, sensory deprivation, sensory-perceptual-motor programs, and sensory-perceptual-motor studies. The sensorimotor checklist devised for this study included 9 fine and 13 gross motor activities and associated neuromuscular and sensory integration components. Results showed direct relationships between fine and gross motor activities and sensorimotor integration. Time samples of fine and gross motor activities showed correlations between repetition and duration. In general, children sought out and repeated preferred activities. (RH)

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CHILD'S PLAY: A SENSORY-INTEGRATIVE PROCESS

by

Jeanette Allison Hartman

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May 1986

ABSTRACT

CHILD'S PLAY: A SENSORY-INTEGRATIVE PROCESS

The present study measured what activities children seek, repeat, and spend time in for sensorimotor development. Descriptive research was conducted in an ethnographic manner. Four variables were measured: Fine and gross motor activities in direct relation to sensorimotor integrative components, repetition, and duration of preferred activities. The hypothesis that children, given ample time and quality play curriculum, will experience sensory integration in spontaneous play opportunities, and thereby seek, repeat, and spend time in preferred activities was supported by research and data collection. Explanation and a discussion of the results are included.

Jeanette Allison Hartman
May 1986

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Chapter 1

INTRODUCTION

Statement of the Problem

Most research regarding play has identified social, emotional, and psychoanalytical benefits of the activity. Despite the influx of information about play, little research has been conducted regarding the biological reasons for physical play in young children. Therefore, little is known about the physiological effects of sensory integration in the play of normal children.

This study was an attempt to demonstrate the direct relationship of physical play to the process of sensory integration. Furthermore, data are presented showing specific relationships of motor activity to sensorimotor integration. Data are also presented regarding repetition and duration of particular motor activities in achieving levels of sensory integration.

Current Research

Research shows that the child is neurologically immature at birth. Thus, innate within the child are drives to receive, organize, and integrate incoming sensory stimuli. This is a natural, maturational process innate within the child for the developing nervous system.

Review of the sensorimotor aspects of play indicates that the normal child naturally gravitates toward motor activity. The child will therefore repeat, and spend time in, motor activities which are stimulating and therapeutic.

With goals to best nurture the child, quality play curriculum and environments were investigated. The literature indicated the need for quality play curriculum to offer a spontaneous, stimulating, free-flowing, child-centered learning environment. The environment should be such that quality amounts of time, space, materials, and equipment contribute to sensory integrative play opportunities.

Research on sensory deprivation also showed that without proper environments and sensorimotor opportunities, difficulties in integration are inevitable. The effects are delayed sensorimotor abilities and distorted perceptions. Thus, an emphasis on quality sensorimotor experiences is vital for the development of all sensory modalities.

The literature also indicated the significance of sensory integration in sensorimotor play in the realm of sensory integrative dysfunctions. Thus, the child who does not successfully integrate due to physiological reasons, will need sensory integration therapy or some type of perceptual-motor program for the stimulation of sensory and motor modalities.

Definition of Terms

Sensory integration is the organization of internal and external sensory stimuli for functional use such that the child can interact with the environment effectively (Ayres, 1972, 1974, 1979).

For the purpose of the study, play will specifically be regarded for its physical effects. These effects are sensorimotor by nature.

It is through sensorimotor play that the child develops sensory integration. Quality play curriculum is the vehicle for providing opportunities for this process to occur. Play curriculum involves a certain child-centered environment which allows for, and encourages, fine and gross sensorimotor experiences. It is arranged for exploration, manipulation, and discovery. It is generally free-flowing such that the child's needs direct her[1] play (Cherry, 1976).

Research Question and Hypothesis

The research question for the study is: Does quality play curriculum provide opportunities for sensory integration?

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[1]The researcher chose the pronouns "she" and "her" to serve as consistent referents to the antecedents used throughout the text. The use of these pronouns should in no way imply that all children referred to in the study are female, nor that the topic under study pertains only to females.

The hypothesis for the study is: The child provided with ample time and quality play curriculum will experience sensory integration in spontaneous play opportunities and will thereby seek, repeat, and spend time in preferred activities.

Chapter 2

REVIEW OF THE LITERATURE

Introduction

Sensory integration is the organization of sensory input in such a way that the child interacts with the environment effectively. Such integration results in the child's appropriate perception of her body, the world in general, an adaptive response, or a learning process. It may be the development of some neural systems working together. Sensory integration is the development of neural activity coordinated together and utilized by the brain in response to sensations (Ayres, 1972, 1974, 1979; de Quiros & Schrager, 1978).

Sensory integration is a lifelong process which begins in the womb as the fetal brain receives information of the mother's bodily movements. Before crawling and standing up are accomplished, an enormous amount of sensory integration must occur within the first year of life. Childhood play then leads to more sensory integration as the child organizes bodily sensations with mastery of gravity, along with sight and sound. In school, reading requires very complex integration of sensations from the eyes, eye and neck muscles, and the special sensory organs in the inner

ear (vestibular apparatus) (Allen, 1984, 1985; Ayres, 1972, 1974, 1979; de Quiros & Schrager, 1978).

Later along the biological lifeline, a dancer or gymnast develops good integration of body and gravity (proprio-kinesthetic and vestibular) sensations to produce controlled and graceful movements. Artists and craftspeople rely upon the integration between their eye (visual) and hand (tactile) sensations.

Sensory integrative functions develop in a natural order. There are basic principles of development in every child. The most basic principle deals with organization of environmental stimuli within the brain. Most development of sensory activity occurs within the first decade of life. The majority of the activity is the process of organizing sensations occurring in the nervous system (Ambron, 1978; Ayres, 1979).

The baseline ability for sensory integration comes from the genes. The child is born with the capacity for sensory integration; however, she must develop it by interacting with many objects in the environment. Action upon the environment demands that the child adapt her body and brain to many physical challenges. The greatest development of sensory integration happens during an adaptive response to sensations (Ayres, 1972).

The child adapts to constant stimuli. Before her body can make an adaptive response, she must organize

bodily and environmental sensations in the brain. For example, when an infant sees a bottle and reaches for it, reaching is an adaptive response. A more complex adaptive response occurs when the infant perceives that the bottle is too far away and crawls to get it. Furthermore, the preschool child on a swing will move her body in response to sensations of gravity and movement. The movement is pleasant because the brain is organizing the stimulus for a useful purpose. Therefore, an adaptive response is mastering a challenge and learning a new concept.

Ayres (1979) stated that no one can make adaption occur for the child. The child needs to make it happen via biological drives. Consequently, the child will naturally gravitate toward physically challenging activities. Each new physical attempt, in turn, is a new experience of sensations.

The Ontogeny of Sensory Integration

Through these adaptive sensations, the child develops motor functions. Gradually, she will choose activities that require more integrative functioning, such as swinging higher or riding a bicycle. The faster the activity, the greater the sensory stimulation, and the more accurate adaptive responses must be.

Until about the age of 7, the brain is primarily concerned with sensory processing, meaning the brain

senses and gains perception directly from sensations. The young child is concerned mainly with bodily movements in relation to sensations. Her adaptive responses are more muscular, or motor, than mental. Thus, these first years are called the years of sensorimotor development (Ayres, 1979; Piaget, 1952).

The child is continually putting her functions together while sorting and adapting to form more complex functions. She strives to master each sensory and motor element. Every present and future activity depends on the sensorimotor foundation which Ayres (1979) termed "building blocks" (p. 15). This sensorimotor development is vital for successful emotional, behavioral, and academic abilities well into adulthood.

A clear understanding of the ontogenesis of sensory integration is obtained by following the major steps in the path of development. Following is the progression of sensory integration from birth up to age 7.

The 1st Month of Life

In the 1st month of life, the infant can already interpret sensations because of natural reflex movements. The sense of touch (tactile) has already been developing in the womb. Touch sensations are emotionally satisfying and they stimulate the brain. Thus, the touching between an infant and a mother is essential for brain development.

The newborn also shows response to the sensations of gravity and movement that come from the inner ears (vestibular apparatus). For example, if the infant is lowered too fast, she will have a clinging reflex. The inner ears tell her she is falling. The flexion she exhibits is a movement of the entire body as well. It is usually the first total-body motor pattern. These innate responses are the substrate for the development of advanced motor skills (Ayres, 1972; de Quiros & Schrager, 1978).

A caregiver learns quickly that carrying or rocking the infant quiets and provides comfort. Sensations of gentle movement tend to stimulate the inner ears and provide a means for advancing the flow of stimuli to the brain. The infant is integrating the sensations.

The infant must practice and organize many movements for future sensorimotor perception. For example, when lying on her back, the infant thrusts her arms and legs playfully. Prone, she makes alternating crawling motions. These movements occur because the sensations from the muscles and joints (proprioception) and inner ears (vestibular apparatus) stimulate the nervous system.

The 1-month-old child will respond to auditory stimuli from a rattle or human voice. She will also make vocal sounds which produce sensations that help to stimulate the speech areas of the brain.

Two other senses, well developed at birth, are smell (olfactory) and taste (gustatory). The sense of smell is keen and alerts the infant to the changing environment. The infant can also taste well. Sucking is an adaptive response that results from taste and smell.

The 2nd and 3rd Months of Life

During the 2nd and 3rd months of age, the infant develops more motor control. The eyes and neck are the first body parts she learns to control. Visual perception now involves more than just looking at something. The eyes must hold a steady image of an object while the neck supports the head; otherwise, the object would appear blurred. For this to occur, the brain must integrate three sensations: (a) gravity and movement sensations (vestibular) from the inner ears, (b) sensations from the eye muscles, and (c) muscle sensations (proprioception) from the neck. This process also helps the infant learn balance and overall motor control (Ambron, 1978; Ayres, 1972, 1979).

The pull of gravity is a consistent and powerful force to the infant who now tries to rise up. This is the first accomplishment on the way to whole motor activity. From the first attempts of rising to mastery of standing, the infant has a strong inner drive to master gravity sensations.

The infant is simultaneously developing eye-hand coordination through all her attempts at aiming, reaching, and grasping. As she integrates bodily sensations with visual signals, she learns to reach straight for the desired object. The sense of touch (tactile) confirms her attempts, and the brain makes an adaptive response. She develops a sensory schema for newly mastered skills.

Frequently, during reaching and grasping attempts, the infant will reach across to the other side of the body crossing the midline. The midline acts as an invisible verticle and horizontal barrier to the body which originates in the brain. Its initial purpose is to guide the child in later years in determining cerebral dominance. As the child grows, the invisible barrier will disappear, usually by the age of six. Therefore, all motor activity which crosses the midline will be an advantage to overcoming this barrier. The child must be able to automatically cross the midline to gain a sense of continuity and coordination between both sides of the body (Allen, 1984, 1985; Ayres, 1972, 1974, 1979; de Quiros & Schrager, 1978; Valett, 1980).

The 4th to 6th Month of Life

By the 4th to the 6th month of life, the baby has had many opportunities to test basic visual, auditory,

vestibular, and tactile senses. Movement has been the vehicle for testing and mastering sensations.

The baby also begins to see her body parts in relation to spatial awareness. She uses tactile and proprioceptive sensations along with visual signals to use her hands in conjunction to what is seen. If the brain receives and coordinates those sensations, sensory and perceptual understanding is further developed.

One of the most important developments at this age occurs spontaneously when the hands are brought in front of the body to clap and touch. This is the beginning of bilateral coordination between the two distinct sides of the body. When an object is added to this experience, the child becomes more aware of this coordination. These actions require an important type of sensory integration that must occur before the child develops right-left discrimination.

These actions are also the beginning motor planning skills which rely on bilateral awareness. Movements must first be planned inside the brain to complete simple and complex sequences of actions in proper order. Each new play activity propels these motor planning skills, and the demand for sensory integration increases, i.e., the baby can sit alone for a short time without losing balance. The automatic muscular reactions that keep her upright are guided by vestibular, proprio-kinesthetic, and visual

adaptive sensations. Also, the development of the prone extension, balancing on the stomach, is vital in developing muscles used for rolling over, standing up, and walking. This ability equally relies upon similar sensations such as the baby sitting alone. The normal baby will spend a good deal of time lying on her stomach.

There is a joy of movement in childhood. The 6-month-old likes to be rocked, held up, turned over, moved about, and swung in the air. The joy comes from experiencing stronger vestibular and kinesthetic sensations which are more easily integrated by the brain. However, the newly adaptive functioning of the brain and nervous system is susceptible to stimulus overload. For example, if the movements are too stimulating or the child cannot integrate the sensations, they will bombard and "disorganize" the nervous system and cause the baby to cry (Ayres, 1979).

Newly acquired locomotion is a tremendous developmental achievement for the baby. Being able to move from one place to another increases the number of objects and territories to be explored. Kinesthetic pleasure alone may also be the primary motivator for locomotion.

Locomotion also gives the child spatial perception with regard to the distance between herself and objects in the world. Good distance judgment helps in knowing how large things are; she will thereby sense the nature of distance through kinesthetic sensations. Sensations

from touch, joint, and muscle stimuli (proprioception) provide additional information to guide movements.

The 9th to 12th Month of Life

By the 9th to 12th month of development, the child relates with more complete interactions between objects and the surrounding space. She can creep longer, with more endurance to explore new and challenging places. Motor independence developed through play has created access to discovering unfamiliar sensory stimuli. New stimuli are continually received and integrated by the brain, for added sensory adaptation.

The adaptations between sensory stimuli and motor activity complete the first steps for future sensorimotor mastery upon the environment (Ayres, 1979; Piaget, 1952). For example, the child can hold her head up (proprioception), stand up supporting her body from the pull of gravity, and balance (vestibular functioning). As the child stands up, the nervous system relays these sensations to the brain. On the continuum, these upright sensations are the beginning of bilateral and proprio-kinesthetic awareness.

Few adults realize the magnificent achievement of the child who stands alone. It is the end product of all the integration of gravity, movement, and muscle-joint sensations since infancy.

The 2nd Year of Life

Within the 2nd year of life, the child gains cognitive understanding from all previous physical attempts. Prior sensory stimuli become familiar, freeing the child to initiate automatic investigation of the environment. The child develops further perception as to how the world and the space around her operate. This cognitive understanding will guide the child through advanced sensorimotor attempts in the preschool years (Piaget, 1952).

Ayres (1979) argued that cognitive development is practically inseparable from sensory and motor development. Until about the age of 2 years, mental life is reliant upon sensations and the control of motor activity. Valett (1980) and de Quiros and Schrager (1978) would also support this statement.

When certain parts of the brain receive incoming sensory and motor impulses, they are sorted and coordinated in the sensory and motor cortex in the cerebral hemisphere (refer to Figure 1). Thus, cognition is the process of sorting, coordinating, registering, adapting, and filing information received from stimuli (Ayres, 1972; Languis, Sanders, & Tipps, 1980).

Piaget (1952) suggested that the human brain must first have concrete knowledge of the body, the world, and the physical forces of each. Abstract thinking is secondary and only begins by age 7 or 8. Abstract thinking builds

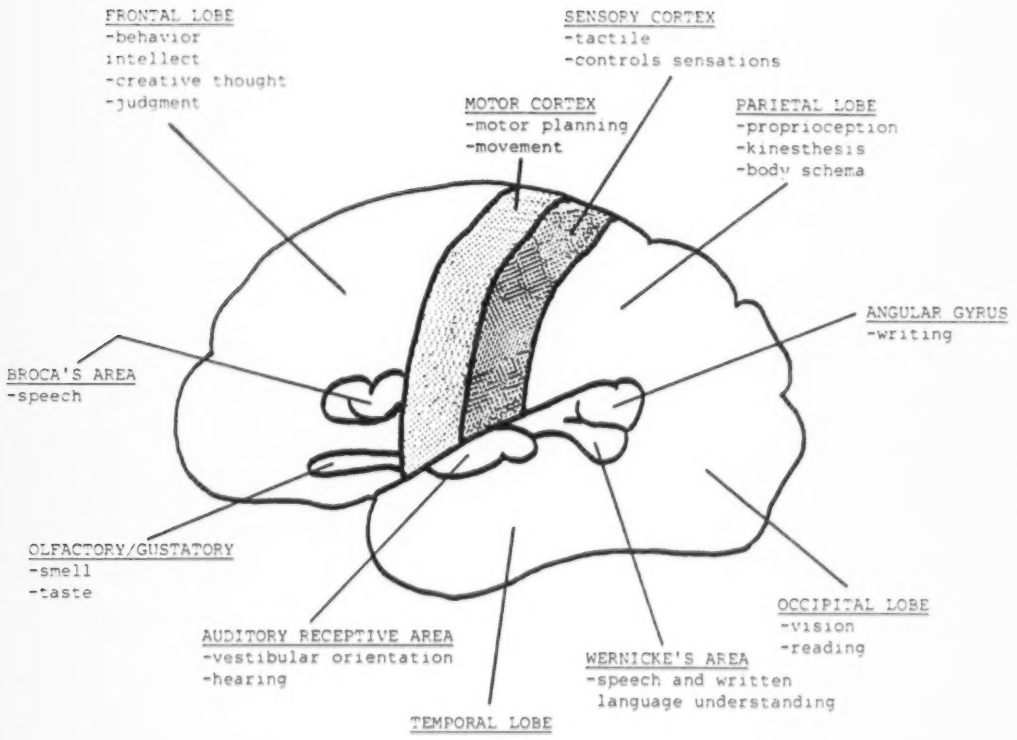

Figure 1. The brain

upon knowledge of how that child is in relation to her surroundings. Seven or 8 years of "play" are major factors in sensorimotor intelligence. This particular integration prepares the foundation for physical, intellectual, social, emotional, and overall personal development.

The Following 5 Years

In the following 5 years, localization of the tactile and proprio-kinesthetic systems are vital in the process of learning. Body schema is also a key factor in determining the learning process.

The accuracy of the tactile system determines the ability to plan movements. At birth, the infant senses when she is touched, and this sends neural messages to the brain. By the 2nd year of age, she can begin to localize where the touch occurs. Additionally, the 2-year-old begins to associate touch with pleasure from the environment and from loved ones. Skin sensations, tactile input, can relay messages independent of sight in the developing child. The developing tactile system can now also tell the 2-year-old where her body begins and ends. A proper developing tactile system will enable the child to "follow" and "listen" to her body. Thus, tactile awareness is more basic than is visual knowledge at this stage.

During the 2nd year, the child practices endless combinations of movement to develop proprio-kinesthetic

awareness. She is gaining additional sensory awareness as to how her body functions and relates to the physical world. For example, she will pick up, handle, drop, throw, pull, push, and walk up and down stairs, exploring the home and the outdoors.

Ayres (1979) advocated that the child needs opportunities to interact with the physical environment as much as she needs food and love. Furthermore, Ayres stated that adults should be more concerned about "the child who does NOT get into everything" (p. 22).

Given ample time, the child will map out bodily movements through physical consequences to develop body schema. Mapping of the body occurs when the nervous system is stimulated by sensations and thereby sends messages to the brain, forming internal sensory "pictures." This is also termed "body percept." In developing body schema, the child will desire activities such as piggyback rides, tumbling, and climbing. The laws of gravity and bodily placement are discovered during these play activities. Through play, the child formulates mental images from sensory stimuli of what she can and cannot do, what feels good, and what is uncomfortable.

The vestibular apparatus, located in the inner ear, provides gravity receptors and works with visual information to guide the child when determining body schema. The vestibular apparatus gives the child an internal sense for

exact body placements among the physical forces in the environment (Ayres, 1972, 1979; Allen, 1984, 1985; de Quiros & Schrager, 1976; Milner, 1970).

The Preschool Years

The preschool years offer time for the child to refine sensorimotor abilities. Established relationships and discovery of independence from the confinement of the physical world are fully evident. Higher cognitive and motor abilities will develop upon established sensory-integrative functioning. Although the preschooler seems established and "just playing," the next few years are still critical in the completion of the nervous system and the adaptive functioning of the brain. The child continues to explore and discover by trial and error. She is designed to continue experiencing and integrating more sensations now than she will in subsequent years of adolescence and adulthood. This unique design of the preschooler is an innate drive to move and do many fine and gross motor tasks.

Simple motor abilities have become relatively automatic before the preschooler combines them into complex attempts. Without being aware at the conscious level, the child readjusts and combines the various simpler motor abilities until some success is achieved in more complex demands. For instance, at an early age, a more complex skill such

as riding a tricycle is not possible until the child has developed automatic responses involved in standing, walking, climbing, and certain limb controls. The higher motor skills call upon the foundation of the simple automatic skills (Lawther, 1977).

During the preschool and primary years, the child gains a sense of fulfillment from sensorimotor functions as she interacts effectively with the world of objects. Sensorimotor functions become more evident as physical play. This play, then, represents more than survival of the organism in testing the new environment. Play is directed more toward deeper sensorimotor awareness, investigation, and self-actualization. When testing gravity, the child finds that she is not quite as dependent on it as she was shortly before; the sensation is masterable and pleasurable.

Sensorimotor activities that are pleasurable and rewarding are the targets of the preschooler and primary aged child. These include gross motor activities such as walking, strolling, running, jumping, hopping, rolling, tumbling, swinging, spinning, sliding, balancing, climbing, and skipping and fine motor activities such as pounding, pulling, pinching, molding, drawing, painting, manipulating, fitting, and cutting.

The Primary Years

Toward the primary years, a final "polishing" of fine and gross motor skills occurs. The child may select group games, hulahoop, jump rope, stilts, simple sports, and activities which demand strength and endurance. An interest in writing and reading will naturally and spontaneously evolve from refined fine motor skills and integrative abilities.

By 8 years of age, the child's tactile system has almost reached maturity. The sense of gravity from the vestibular system is most likely mastered. Proprio-kinesthetic awareness is refined and automatic in appropriate childhood motor skills. Auditory and visual abilities are coordinated to guide the child in a whole sensory approach to academic demands. Thus, sensations are more wholly integrated, identified, predicted, and useful.

Sensory Integration and the Brain

An understanding of sensory integration leads the researcher to introduce the role of the brain as related to the integrative process. It is the human brain that enables one to know and interact with the environment. Learning, such as motor and academic learning, is part of that environment and is just one of the many functions of the brain.

Cerebral Development

The skeleton and the brain are immature at birth. As either system matures, the various parts become more firmly connected functionally and structurally to enable each to perform its function. Plasticity (flexibility; the ability to modify) of the immature brain is vulnerable and adaptable to sensations from the environment. This plasticity diminishes with age. The direction of growth of the skeleton and brain is dependent upon various environmental encounters and innate maturational tendencies. Bones grow and form in relation to muscles bearing against them. Similarly, neurons grow and develop according to the amount of brain activity that is stimulated. Thus, motor activity occurring during growth can mature skeletal development; sensorimotor activity modifies neural growth. Since plasticity, or the ability to modify, diminishes with maturation, the longer the delay for the child to encounter sensorimotor experiences to develop the functional systems of the brain, the more difficult it will be to modify cerebral maturation (Ayres, 1972; Scheibel & Scheibel, 1964). Ayres (1972) claimed that "neurological organization is virtually completed within the first decade of life" (p. 17).

Key to the concept of brain development and function is the influence of the environment upon the child and the child in reciprocation to the environment. This

interchange between the environment and the child constitutes the essence of a sensory integrative and sensorimotor response.

Cerebral Functioning

The primary function of the brain is to translate sensory impulses into meaningful information and to organize an appropriate motor response. The process is most obvious and direct in the child. However, the sensory integrative process, being more subtle and covert than the motor, is not often called to attention by an observer.

Environmental stimuli act upon the child through various sensory receptors. This causes a constant changing pattern of sensory input. Russell (1959) proposed that afferent flow (input) into the nervous system is basic for change in the organism's reaction to the environemnt. The nervous system selects acceptable afferent flow in relation to adaptation and survival. Russell (1958) considers two important factors of brain development and integration to be (a) the tendency of nerve cells to repeat patterns of activity, and (b) the capacity of organisms to encourage or discourage a response from an advantage point. Consequently, the organism is concerned with organizing sensory input as a basis for suitable motor responses.

Successful transmission of neural impulses through the nervous system to the brain depends greatly upon the myelinal state of the nerve fibers. The myelin sheath surrounds the nerve fibers. It is a white insulating material which aids in the smooth and speedy transmission of vital neural messages to the brain. The myelin sheath develops early in gestation. It is immature at birth and continues to form through the early primary years.

Healthy input of environmental sensations depends upon the role of the myelin sheath. Innate drives to move in the young child are in direct relation to the maturity of the myelin sheath. The vestibular apparatus contains calcium-carbonate crystals which activate myelination during motion. It has been postulated that motion, such as rocking and locomotion in the early years, has a direct effect on the vestibular apparatus. In turn, this myelination process enhances nerve development via transmission of neural impulses directly to the brain (Ambron, 1978; de Quiros & Schrager, 1978; Milner, 1970). Since successful sensory integration depends on the brain's ability to receive sensory input and to organize and accommodate environmental sensations, myelination is vital in assuring that the integrative process is a smooth one.

Intersensory Integration

Another important determinant of sensory integration is that of intersensory integration. It is equally basic to

all of the brain's integrative abilities. Intersensory integration is the interplay and convergence of all sensory modalities within the brain.

The ability for intersensory integration may be a major source of the child's advanced adaptive abilities. It has been noted by Birch and Lefford (1963) that intersensory integration follows a developmental sequence, with a faster rate of maturation of the function occurring before 8 years of age. Furthermore, by 8 years old, a vital maturation point has taken place in visual, tactile, and proprio-kinesthetic sensory integration. By approximately 10 years of age, audiovisual integration has matured (Ayres, 1972).

The convergence of all stimuli is not necessarily the primary process of integration. The process of accepting some and rejecting other information at certain convergent points within the brain is the basis for integration. Ayres (1972) indicated that afferent stimuli do not necessarily affect one sensory modality, but that there is an interdependency and communication among all sensory modalities.

The most commonly noted modalities evident in intersensory integration are visual, auditory, olfactory, proprio-kinesthetic, tactile, and vestibular. For example, experiments with human beings wearing lenses demonstrated, behaviorally, how the central nervous system utilizes

intersensory integration in an adaptive response. The lenses invert the visual image.

After users wore them in action for a certain time period, the inverted visual field was perceived as right side up. It was noted that the visual, tactile, and proprio-kinesthetic inputs reassociated through intersensory integration enabled a vital adaptive response (Ayres, 1972; Magill, 1980).

Movement and the Brain

Another major vehicle for successful sensory integration in the brain is movement. One of the most powerful organizers of sensory input is movement which is adaptive to the child.

Kephart (1968) referred to the adaptive response as the human organism cooperating and adjusting to a satisfactory degree with the environment. When considering movement as an integrative process, emphasis must be on appropriate activities to the survival interests of the human organism, the child.

Motor demands placed on the child depend on previous adaptation of the nervous system and the brain. Usually, motor demands result in purposeful or goal-directed responses and can call upon the integrative ability of the brain. However, as new demands are placed on the brain, it will at least attempt an adaptive response based on the innate

tendency to organization and accommodation of new stimuli.

It has been recognized in the work of Hyden and Egyhazi (1962) that when rats successfully met a sensorimotor (integration of sensations and movement) task, optimal gains in learning were made.

The integrating effect of an adaptive motor response can be observed clinically with sensory integration therapy. The child who receives the therapy demonstrates random, ineffective motor actions resulting from a low integrative power. Integration is achieved by organizing and causing an adaptive response, and therapy is achieved when that response demonstrates more complex skills as opposed to previously elicited ones.

This integration achieved may result from the fact that the motor cortex is one of the major centers for integrating convergent sensory stimuli related to motion. Buser and Imbert (1961) suggested that the motor cortex of a cat acts as a common center for sensorimotor integration, a function not shared as effectively by surrounding cortex areas (refer to Figure 1 [p. 16]) (Ayres, 1972).

The brain is the determining factor in sensory integration. As it cooperates with motor stimuli, the results are adaptive sensorimotor responses. In the life of the child, this is play--sensorimotor play. Research follows in the text as to which area of child's play best facilitates and enhances sensorimotor development.

Play

The sensorimotor development of the child is a natural process. The first decade of life is spent in what adults would term "play." To the child, play is her life. It is a connection with the physiological drives of development. From a neurological point of view, play is the act of physiological responses for the development of cerebral and neuronal functions. Neuropsychology would explain play as the child's attempt to acquire sensory stimulation for increased sensory integration. Early childhood education would most likely recognize it for its social, emotional, and psychoanalytical drives. Elementary education often explains it as a surplus of aimless activity best tended to at recess (Ayres, 1972, 1979; de Quiros & Schrager, 1978; Frost & Klein, 1979; Levine, 1960).

Piaget (1962) very obviously recognized play for social, emotional, and intellectual benefits. However, he distinguished play for its sensorimotor element as well. A connection was made between the act of play and the physiological drives behind it. His theory was based primarily on a biological model of environment-organism interchange.

It is by the works of Ayres (1972, 1974, 1979) that the researcher recognized an element of "play" in an environment-organism interchange. Throughout Ayres' research and involvement with children, she mentions Piaget

and the various developmental stages of the child physiologically. The relationship of Ayres to Piaget is the aspect of sensorimotor development.

With her emphasis and background in occupational therapy, Ayres has pioneered work with sensory integration therapy. This led the researcher to study therapy and its connections to sensorimotor development. Observations of sensory integration therapy provided insight to a common denominator of therapy and sensorimotor "play": sensory integration.

Sensory integration therapy serves those who need normalization and reorganization of sensory processes. It provides prescribed, structured sensorimotor activities which are in unison with the natural play of normal children. Once more, it was during investigation of therapeutic approaches that the researcher realized another connection of therapy and play: sensorimotor activities.

During physical play the child develops sensorimotor functions. It is through the combination of sensory (input) and motor (output) functions that sensorimotor development is achieved in the child. Thus, research regarding physical play is presented. Physical play has been referred to by various researchers as play that is biological, functional, stimulus-seeking, optimal-arousing, exploratory, manipulatory, and discovery-oriented. These terms relate to the play aspect of physical activity and are presented as they pertain to theory.

The History and Theories of Play

Play is universal and essential to humanity. Since early civilization, people have left artifacts depicting the importance of play to physical, intellectual, emotional, social, and spiritual well-being of the individual.

The Greek philosophers Plato (427-347 B.C.) and Aristotle (384-322 B.C.) recognized the value of play for promoting healthy development. Early educators such as John Amos Comenius (1592-1670), Jean-Jacques Rousseau (1712-1778), Johann Pestalozzi (1746-1827), and Friedrich Froebel (1782-1852) rebelled against the harsh discipline and rote memorization that characterized the education of children during their lifetimes. They stressed the importance of play as both a natural drive of childhood and a major avenue for learning.

Although play has long been recognized, theorists have expressed contrasting definitions of play and have disagreed about the biological and psychological elements of play. Frost and Klein (1979) suggested that play activity be observed and measured; however, they did not indicate how. Mitchell and Mason (1948) illustrated this point by presenting the following theories of play:

> Friedrich Schiller (1875): The aimless expenditure of exuberant energy.
> Friedrich Froebel (1887): The natural unfolding of the germinal leaves of childhood.
> Herbert Spencer (1873): Superfluous actions taking place instinctively in the absence of real actions for gratification.

> Karl Groos (1898): Instinctive practice, without serious intent of activities that are later essential to life.
>
> Luther Gulick (1920): What we do because we want to.
>
> John Dewey (1922): Activities not consciously performed for the sake of any result beyond themselves. (Mitchell & Mason, 1948, pp. 103, 104)

Classical Theories

Classical theories of play are described by Frost and Klein (1979) as the Surplus Energy Theory by Karl Groos, the Relaxation Theory by G. T. W. Patrick, the Recapitulation Theory of Luther Gulick and G. Stanley Hall, and the Instinct-Practice Theory by Karl Groos.

Main ideas from these four classical theories do not directly explain sensorimotor drives. The Surplus Energy Theory maintained that an organism's drive for activity was expenditure of surplus energy. This may be interpreted as neuronal or sensory stimulation release; Patrick did not indicate. The Instinct-Practice Theory indicated the organism's need to replicate activities for future skills. This may be interpreted as innate drives for activity. Groos did not indicate such an assumption. This led the researcher to contemporary theories of play.

Contemporary Theories

Three main contemporary play theories are recognized as the psychoanalytical (Freud), developmental (Piaget), and behavioral (Skinner) theories.

The theory which supports this study is the Cognitive-Developmental Theory of Jean Piaget (1962). He offered a comprehensive theoretical framework to understand the intellectual development of the child. In addition, he included the biological drives for play as sensorimotor drives. His theory of development is based primarily on a biological model of environment-organism interchange. Further described were five categories of play: functional play, constructional play, symbolic play, sociodramatic play, and games with rules. Functional play is described as it correlates closest to the purpose of the study.

Functional and Sensorimotor Play

Functional play consists of simple repetitive actions. This play is also referred to as exercise play and occurs during the sensorimotor period of development (birth through approximately 2 years old). These behaviors soon lead to newly acquired motor responses and combinations. Thus, through functional, physical play, the child learns physical capabilities and cause-effect relationships within the environment.

Functional play is not limited to the first 2 years of the sensorimotor stage. It is continual throughout childhood whenever new skills or particular motor functions are acquired.

Athey (1974) included a statement by Frank (1968) regarding sensorimotor development as follows:

> The child learns not only to look but to see, not only to hear but to listen, not only to touch but to feel and grasp what he handles. He tastes whatever he can get into his mouth. He begins to smell what he encounters. He can and will, if not handicapped, impaired, or blocked, master these many experiences through continual play . . . the most intensive and fruitful learning activity in his whole life cycle. (Frank, 1968, p. 435)

Athey (1974) supported play in the role of sensorimotor development. She stated that "from birth the child needs a play environment rich in visual, auditory, and tactile experiences" (p. 38).

Frost and Klein (1979) stated that "the human body is wonderfully equipped with perceptual modalities for transmitting information to the brain for organization and response." These modalities are auditory, visual, tactile, kinesthetic, gustatory, and olfactory. Frost and Klein continued: "They [modalities] are developed naturally or informally as children play" (p. 40).

Frost and Klein included specific play activities which enhance sensorimotor functioning. These are gross motor activities, fine motor activities, body awareness, spatial awareness, directional awareness, balance activities, integration activities, and expressive activities.

Furthermore, Frost and Klein suggested that being sensitive to sensorimotor abilities enables the adult to extend and enrich the child's play by facilitating the

transition of learning new motor skills of one stage to another. They also recognized that remedial and regular physical education curriculum disregarded the value of free play in sensorimotor development. In conclusion, Frost and Klein added that the child needs ample opportunities to develop physically through natural play.

Smith (1969) stated that in the course of physical play, the child's body acts and reacts in a continual process of sensory perception. As she moves, sensory perception changes. This perception is a process through which the child receives, extracts, organizes, and interprets sensory information. It is through movement, during play, that sensory stimuli begin this process.

Kephart (1960) focused on the nervous system in terms of sensorimotor processes. He indicated that as the child moves, there is input and output of sensorimotor responses and motor-sensory responses. Thus, adequate motor responses, acquired during physical play, can be developed by providing sensory opportunities.

Luria (1966) supported sensorimotor activity during play as being the child's sensory modalities changing to stimuli of light, sound, feeling, smelling, and tasting, all during the movement process. As the child explores and manipulates objects in the environment, sensory modalities are activated by external stimuli which alter internal stimuli to the senses. As the child integrates

stimuli via the senses, sensory perception is achieved and stored in the brain for future actions.

Hendersen (1981) discussed the importance of play through stimuli and movement. She contended that one of the conditions of healthy development is stimulus. Without it, the central nervous system would not function correctly. This essential stimulus comes via movement; movement via play. Thus, during play, the child needs to run, jump, throw, swing, catch, and balance. The purpose is to develop strength and coordination of the large muscles, enhancement of spatial awareness and motion (kinesthesia), and pleasure.

Ellis (1973) cited some specific definitions for intrinsic motives for physical play. For example, Barnett (1963) defined intrinsic play as exploratory and its behavior as being motivated by the need to increase the rate of stimulation (which is sensory by nature). Hunt (1965) described play as being motivated by the inherent factors in the organism's interaction through sensory receptors.

Among researchers, there is agreement that certain forms of play stem from a drive for optimal arousal which is concerned with stimulus-seeking. The organism has a need for stimulus-seeking activity that is only interrupted by drives of hunger, rest, and sleep. The normal state of the organism reflects the state of the nervous

system, which is in a constant state of activity. Therefore, the normal organism needs to be in constant receipt of sensory input from the environment which satisfies a need for stimulation (Ellis, 1973).

Child's play is an innate, natural drive for the development of sensorimotor functions. The different theories of play support play in the daily life of the child. An environment where the child can ensure sensory integration through sensorimotor activities occurs within quality play curriculum. Thus, following is research regarding quality play environments that are child-centered.

Quality Play Curriculum

Quality play curriculum is fully encompassed by excellent early childhood philosophies and practices. Presented here is information specifically addressing the term "quality" when referring to early childhood programs which often provide rich play curricula.

There does not seem to be a great amount of disagreement among trained and sensitive persons who guide young children as to what constitutes "quality" child care. Differences of opinions, however, are more varied when referring to play curriculum. The challenge, then, is bridging any gaps which exist between a functionally appropriate, quality early childhood program and the views of quality play curriculum.

During the past two decades, many public policy efforts have attempted to define the dimensions of high quality in early childhood programs. According to Hilliard and Caldwell (1985), the Federal Interagency Day Care Requirements (FIDCR) attempted to establish minimum quality standards. The National Day Care Study of Ruopp, Travers, Glantz, and Coelen (1979) attempted the issue as well. Also mentioned was the Child Development Associate National Credentialing Program (CDANCP), an organization that contributed to quality child care by compiling competency standards for teacher training. Furthermore, the National Association for the Education of Young Children (NAEYC) (1982) initiated a project to identify and inform teachers in preparation for their endeavors by issuing the Early Childhood Teacher Education Guidelines for Four- and Five-Year Programs.

Most attempts have recognized these qualifications in which children

1. Are well-nourished, healthy, and safe, with desirable teacher-child ratios.

2. Have adequate space, materials, and equipment for learning.

3. Have well-trained staff which implement an organized, well-planned program developmentally designed for children.

4. Have strong communication links with parents.

Hilliard and Caldwell (1985) called attention to additional qualifications that are too often unrecognized and consequently unmet, which include:

> 1. Affective and spiritual needs met in a happy, emotionally stress-free environemnt.
> 2. Discovery as serious business of the young child.
> 3. Home-school continuity by means of bringing qualities of the home environment into the school.
> 4. Cultural saliency for a deeper understanding of all children served for the basis of belonging, esthetic values, and academic potentials.
> 5. Humane philosophies in regards to guidance and direction of the school's goals and the treatment of persons. (Hilliard & Caldwell, 1985, pp. 20-21)

Any quality early childhood center encompasses quality play curriculum throughout the entire program. A program which provides quality play curriculum operates under the principle that the child directs her own learning, and learns by doing. This would lead to opportunities for natural, spontaneous play experiences throughout the day.

The curriculum allows full opportunity for social, emotional, intellectual, and physical development through play that is self-directed, exploratory, and manipulative. These activities in play curriculum serve both fine and gross motor development as the vehicle for developing sensory awareness within the environment.

New concepts and ideas are discovered through a balanced curriculum of quiet and active experiences in creative art, books, storytelling, blocks, woodworking, dramatic play, science, math, music, creative movement, and

sensory activities in mud, sand, and water, both indoors and outdoors.

"Free-flow" time is a common characteristic of play curriculum. The child moves freely about various activites as listed above. She may initiate her own "curriculum" for play. Teachers are stationed in different areas to ensure supervision and to encourage children's involvement. Small group times are planned for close contact with the primary caregiver at the center.

Cherry (1976) has set a reputable example of a particular curriculum where play is highly valued and implemented in her book, Creative Play for the Developing Child. Cherry stated that play as curriculum is not necessarily a new idea. The confusion comes from the adults who try to decide "how" the child should play. In a natural, spontaneous environment, the child will direct her needs.

Play curriculum stresses the importance of play-learning attitudes and environments among children and adults alike, as opposed to the more formalized work-teaching approach of traditional settings.

Long-term goals for the creative play program are secondary. Primary goals are for moment-to-moment, hour-to-hour, and day-to-day achievements, rather than objectives that are far removed, or yearly expectations. In comparison, the step-by-step approach through play curriculum is growth-enhancing and potential-encouraging.

Major components of play curriculum focus on the criteria listed below (Cherry, 1976):

1. Movement in relation to how and what the child learns.

2. Overall development rather than one single aspect of growth.

3. The totality of an experience rather than isolated parts.

4. Creative environments in which both children and adults are encouraged to explore, imagine, invent, innovate, express feelings and emotions, and enjoy life experiences.

5. The inner world of the individual.

6. Experience through sensations and reactions.

7. Self-evaluating and self-correcting activities.

Cherry (1976) provided a comprehensive list as to what physical spaces or areas foster quality play curriculum. They may be any of the places listed in Table 1.

Spontaneous play in these areas is "activity" to the child. This activity is nourished in an environment with plenty of materials, choices, space, time, and guidance. Quality play curriculum emphasizes visual, auditory, gustatory, olfactory, tactile, and kinesthetic development together with motor opportunities of all types. Play is a priority based on the philosophy that developing sensorimotor abilities lead to perceptual skills.

Table 1. Physical Spaces Which Foster Quality Play Curriculum

Spaces	
Interest center	Rug area
Learning center	Story area
Discovery center	Block area
Science center	Housekeeping center
Art center	Dramatic play center
Painting center	Quiet corner
Activity center	Alone place
Concept/Display center	Backyard/Front yard/Play yard
Table	Bike area/Bike path
Corner	Digging area/Sand play
Playground	Sandbox
Patio	Construction/Carpentry center
Lawn	Group activity center
Water play area	Work area
Gardening area	Listening center
Manipulative center	Language center
Book/Reading center	Cooking area
Math center	Music/Movement area
Open area	Pet/Living center

Source: Cherry, 1976, pp. 18, 19.

It must be mentioned that even though professionally recognized early childhood education programs offer "play curriculum," this does not ensure that staff understand that spontaneous play can be a vehicle for sensory integration. It is the goal of the researcher to provide information to bridge the gap between theory and practice.

Sensory Integration Dysfunction

Consideration of the impact of an incompetent physiological sensorimotor system provides vital data for understanding a competent one. Specific information regarding the functions of the brain, the nervous system and its neural networks, and the complex role of sensory integration has come from studying sensory integrative dysfunctions.

Data regarding the physiological needs of the child with a dysfunction have been the impetus to guide professionals into the approach of sensory integration therapy. Sensory integration therapy is a natural means of prescriptive, therapeutic activity for the normalization of sensory functions. Therapy has guided professionals to the sensorimotor needs not only of the child with a dysfunction, but also, to those of the normal child, whose need for sensorimotor stimulation usually derived through spontaneous play is equally vital. Thus, all children need sensorimotor stimulation to varying degrees, depending upon individual, physiological needs.

Information regarding sensory integration dysfunction is presented here to provide a better understanding of the role of sensory integration in the development of the child.

Sensory integration dysfunction is described as a disruption of the information gathering and processing functions of the central nervous system which is reflected in motor behavior and learning patterns (Ayres, 1972, 1974, 1979; Umphred, 1985). A dysfunction indicates that the brain is not processing or organizing the flow of incoming (afferent) environmental stimuli. Thus, the stimuli do not get channeled into necessary areas of the nervous system. Without good sensory integration, learning and functioning are difficult, and the child often feels uncomfortable about herself and cannot easily cope with ordinary demands and stress. Ayres (1979) stated that 5 to 10% of all children have some type of sensory integrative dysfunction.

Ayres (1974, 1979) stated that even though irregular activity within the brain results in a sensory integrative dysfunction, most neurologists will not find anything wrong. Obvious neurological concerns usually lie in tangible fine and gross motor functions. Dysfunctions may go undiagnosed due to the discrete symptoms of sensory processing problems. The most commonly discrete concerns undiagnosed are (a) hyperactivity, (b) behavioral problems,

(c) speech development, (d) muscle tone and coordination, (e) motor planning problems (slow at tying a shoe, difficulty catching a ball), and (f) learning disabilities. Some dysfunctions may develop slowly over long periods of time, a condition which standard assessment tools cannot test (Ayres, 1979; Gubbay, 1975; Umphred, 1985).

The child with a sensory integrative dysfunction often develops unevenly. Some parts of the nervous system are in disarray. Other parts may function normally; thus, the child will be up to age expectations in some areas and delayed in others. The child is more likely to have greater problems evident in motor planning and lesser problems with reasoning and intellect (Gubbay, 1975).

With regard to reasoning and intellect, the brain needs to be fed by billions of neurons. The number of neurons and their connections within the brain affect this process. A dysfunction lies in the irregular interconnections of the neurons. To produce full intelligence, a brain must have its full potential of neurons functioning together. Note that a sensory integrative dysfunction is a "malfunction," not an absence of function (Ayres, 1979; Levine, 1960).

Sensory Integration Therapy

Allen (1984, 1985), Ayres (1972, 1974, 1979), Blane, Jordan, and Streets (1975), Connolly (1970), Emde and

and Harmon (1984), and Gubbay (1975) all support assessment and treatment of sensory integrative dysfunctions with sensory integration therapy, which is a natural approach to intervention. It is a holistic approach to develop the entire body, all of the senses, and the brain. Therapy is much like a structured, prescriptive form of play through fine and gross motor physical attempts.

For the normal child who needs general neurological maturation, the therapy could not be harmful. Ayres does caution that adults who administer any form of sensory integration therapy must be properly trained, however. Improper use of the therapy could over- or understimulate the nervous system, creating havoc from within.

"Sensory integration therapy refers to skill and performance in development and coordination of sensory input, motor output, and sensory feedback" (American Occupational Therapy Association, 1982, p. 11). Sensory integration therapy is an approach to the application of neurophysiological and developmental principles through purposeful activities. Therapy is based on the major research and theoretical principles of A. Jean Ayres. Therapy can be sought through the services of physical and occupational therapists.

Theoretical Constructs

The theoretical framework for sensory integration and therapy began during the 1950s and is continually

developed with ongoing research. The theories are based on brain and behavioral research and observation. Therapists use knowledge of the brain, the nervous system, human development, human behavior, and movement activity.

Therapists are concerned with the client's response to various sensory stimuli, ability to process sensory information, ability to perform adaptive responses, and the quality of the response. Functional, emotional, and social responses are equally evaluated. These responses are focused on individual sensory systems such as vestibular, tactile, proprioceptive, kinesthetic (or proprio-kinesthetic), visual, auditory, gustatory, and olfactory components. Results may indicate deficits in psychological, social, cognitive, physical, medical, or speech and language status and are referred to accordingly (American Occupational Therapy Association, 1982; Ayres, 1972, 1974).

The therapy process usually consists of self-directed, purposeful activities that provide selected sensory input primarily through tactile, vestibular, and proprio-kinesthetic systems. By providing an adaptable environment, individualized activities, and a mutual trusting relationship between the client, parent, and therapist, desired adaptive sensory responses can be achieved. With this foundation, cognitive skills, behavioral control, social maturity, and motor skills can develop in a more natural sequence. Treatment may be individual or group-oriented.

It may consist of 30- to 60-minute sessions. Often, the effects seen are immediately, or they may appear 30 minutes later.

The whole concept of sensory integration and motor activity is to increase organization in the brain. The goal of therapy is aiming for appropriate adaptive responses to stimulation. Adaptation then leads to organization and useful responses. For example, a child stands on a surface. The surface is tilted. The proprioception and vestibular input indicate to the brain that postural changes are necessary to maintain balance. A well-integrated brain will make this process seem instantaneous. If there are gaps in the process, or if the sensory perception is amiss, the result will be clumsy, inadequate responses to the tilted surface.

The target sensory modes for therapy are tactile, vestibular, and proprioceptive. It is these modalities that lay the foundation for further sensory perception. Ayres (1972, 1979) theorized that the tactile system is the primary mode for sensory integration. Touch is one of the predominating senses closely linked with general neural development and early childhood behavior. The vestibular system enables the child to detect motion and body position in space. This modality cooperates with tactual and proprioceptive input for conscious awareness of the postural state to the physical world. Proprioception refers to

information arising from within the body: muscles, joints, ligaments, and receptors associated with the brain. Proprioceptive impulses to the brain are critical in motor action. These particular modalities are determinants in the child's reception of additional, useful auditory, visual, gustatory, and olfactory stimuli.

Therapy Activities

From these theoretical constructs. sensory integrative activities and equipment were developed. The equipment used has been designed to entice the child with the dysfunction, as the normal child would be, to participate in spontaneous play activities. The two most standard pieces of equipment used during therapy are the scooter board and the bolster swing. These two pieces of equipment were chosen because they stimulate certain sensory systems. The responses to the equipment reflect early developmental movement patterns, which are substrata for future complex motor tasks. The more standard activities and equipment used during therapy are listed in Table 2.

The Connection Between Therapy and Play

The relationship between sensory integration therapy activities and the sensorimotor play of normal children is very similar. The main sensory approaches of therapy

Table 2. Standard Sensory Integration Therapy Activities/Equipment

Activities/ Equipment	Sensory Input Provision	Procedures
Hammock	Tactile, Vestibular, Proprio-Kinesthetic, Postural Mechanism	The client sits or lies inside a net-type hammock, suspended from a ceiling, to spin or swing.
Large Balls	Tactile, Vestibular, Proprio-Kinesthetic, Postural Mechanism	The client is moved back and forth, lying or sitting.
Balance Board	Tactile, Vestibular, Proprio-Kinesthetic, Postural Mechanism	The client sits, stands, lies, and kneels.
Monkey Swing	Vestibular, Proprio-Kinesthetic	The client bounces up and down.
Tire Swing	Vestibular	The client sits, spins, and slowly unwinds.
Rolling	Tactile, Vestibular, Proprio-Kinesthetic, Laterality, Motor Planning	The client rolls in and out of a sheet.
"Sandwich"	Tactile, Proprio-Kinesthetic	The client lies between two mats. The therapist presses from the top.
Obstacle Course	Vestibular, Kinesthetic, Gross Motor Planning, Space Perception	The client creeps through the course.
Trampoline	Tactile, Vestibular, Proprio-Kinesthetic	The client sits, lies, or stands while bouncing.
Barrel/Inner Tube	Tactile, Vestibular, Proprio-Kinesthetic	The client rolls inside.
Bicycle/ Tricycle	Motor Planning, Eye-Hand-Foot Coordination, Postural Mechanism, Bilaterality	The client rides cycle.

Table 2 (continued)

Activities/ Equipment	Sensory Input Provision	Procedure
Vibrator Platform	Tactile	The client sits or stands.
Manipulatives	Visual-Motor, Visual-Spatial, Tactile, Proprio-Kinesthetic	Bead stringing, painting sewing cards, tracing, and "Mr. Potato Head."
Sand, Gravel, Water Play	Tactile, Visual-Motor	The client manipulates properties.

Source: Compiled from Ayres, 1974; Montgomery, 1978; Sensorimotor Activities, 1977.

are tactile, vestibular, and proprio-kinesthetic, all of which are found in the fine and gross motor activities of quality play curriculum.

The relating gross motor activities reflected in normal settings are balance activities, (invented) obstacle courses, tricycles, tire swings, (spontaneous) rolling, (inflatable) balls, and sand and water play. Occasionally, gross motor activities such as trampolines, barrels or inner tubes, scooter boards, and monkey swings can be found.

The relating fine motor activities reflected in normal settings are working with manipulatives, bead stringing, painting, sewing cards, and tracing.

Ayres (1979), Sensorimotor Activities (1977), and Valett (1974, 1980) agree that most of these activities labeled "therapeutic" are found in the everyday spontaneous play of children. Some particular activities may not be available in regular settings; however, that is not to state that the child would not gravitate toward them if they were provided.

Sensory Deprivation

Professionals in the sciences and education alike are concerned about providing appropriate environments for the child to explore and manipulate in order to ensure opportunities for sensory integration. Researchers such as de Quiros

and Schrager (1978) and Ayres (1972, 1974, 1979) advocate the benefits of appropriate motor activities to the development of sensory modalities.

Sensory Deprivation Studies

The wealth of data available regarding stimulation has also aroused concern regarding sensory deprivation. Ellis and Scholtz (1978) and Zubek (1969) have submitted some theories of the effects of sensory deficits to the human organism. Ellis and Scholtz (1978) reported that in a state of stimulus deprivation, humans tend to seek varied stimulation. In fact, when exposed to an overload of stimulation, humans practice avoidance. Ellis and Scholtz's theory has urged theorists to hypothesize the existence of an optimal range of stimulation or arousal innate within a human in relation to physical activity. Avoiding stimulus extremes, either low or high levels, would set this preferred state of arousal.

Leuba (1955, 1961) developed the concept of optimal arousal when he suggested that "the organism tends to acquire those reactions which, when overall stimulation is low, are accompanied by increasing stimulation; and when overall stimulation is high, those which are accompanied by decreasing stimulation" (Leuba, 1955, p. 27).

The optimal arousal theory assumes that the human organism will maintain a state of homeostasis to continue

or restore the flow of sensory variation within a comfortable, satisfying range. There is a continual striving to approach and maintain the state of optimal sensory variation because of its rewards (Ellis & Scholtz, 1978).

Zubek (1969) specifically reported a 15-year study regarding the effects of sensory deprivation with human adult subjects. The experiment originated at McGill University in Montreal, Canada. Subjects were clinically deprived of sensory input; they reported hallucinations, showed intellectual and perceptual deterioration, and displayed increased irritability.

Furthermore, experimental reviews by Beach and Jaynes (1954), Reisen (1961, 1966), and Thompson and Schaefer (1961) summarized findings of stimulus reduction. It was reported that animals deprived of some input modality (e.g., vision) during development suffered physiological damage. They concurred that long-lasting deprivation may not only damage sensory modalities, but also be irreversible with sensory input. A decrement in perception and perceptual and sensory learning resulted in sensory deprivation as well. The perceptual and sensory modalities examined were tactile, gustatory, kinesthetic, spatial discrimination, visual and auditory perceptions, circulatory, respiratory, and skeletomuscular activity (Zubek, 1969).

According to Zubek's findings, the effects of restricted environments during childhood have been less extensively researched. Dennis and Dennis (1951) greatly reduced the normal amount of social interaction and the availability of manipulation on the environment in rearing twin females until the age of 13 months. The results showed the children to be slow in developing some basic motor skills such as sitting alone, standing with support, and usually, directed reaching and grasping (Zubek, 1969).

The research of Spitz (1945, 1946), Goldfarb (1955), and Dennis (1960) showed that institutionalized children who had poor social contact and physically limited opportunities for stimulus arousal demonstrated signs of low intelligence (perception), passivity (low activity levels), and dependency (emotional and physical) (Zubek, 1969).

Various research has been conducted concerning the characteristics of the environments of the sensory-deprived child. Such factors include family income, racial differences, absence of a parental figure, lack of appropriate sensory experiences, and lack of manipulation and exploration upon the environment as considerable variables.

Spitz (1946) and Goldfarb (1945) have indicated the very serious consequences of early sensory deprivation on later life. Comparison by Skeels (1965) of institutionalized children and those placed in foster homes showed

that environmental stimuli have a great impact on the intellectual development of the child. Fowler's (1962) work indicated that early intervention with the stimulus-deprived child will produce changes significant enough for greater gains in academic achievement. Witkin (1960) and Bolger (1952) supported perceptual training in relation to their work with young children, which indicated that intellectual growth, improved coordination, and motor activity may result from a training program.

A study by Lietz (1972) examined the perceptual-motor abilities of the kindergarten child in determining if significant differences existed between disadvantaged children whose family income was lower than $3,000 per year and advantaged children from families with incomes above that level.

The research initiated assumed that effects of early sensory deprivation have caused the disadvantaged child to begin with an inferior set of cognitive skills as compared to her middle-class counterpart. Additional factors examined were sex and racial differences.

The study included 100 subjects with an age range of 64 to 75 months: 50 economically disadvantaged and 50 advantaged kindergarten children, with approximately the same number of males and females in each group.

The Purdue Perceptual-Motor Survey by Roarch and Kephart (1966) was individually administered. Four major

areas in perceptual-motor development were measured: balance and posture, body image and differentiation, perceptual-motor match, and form perception.

The results indicated that 50 advantaged kindergarten children performed significantly better than 50 disadvantaged kindergarten children. Also, males performed as well as girls, and the white and black disadvantaged children performed equally well, except on the perceptual-motor match.

Movement programs are not only for the child with a perceptual or sensory integration dysfunction, but also for the normal child who may need enhancement or stimulation due to early deprivation or an immature biological need. Research regarding what sensorimotor and perceptual-motor programs have to offer the normal and special child follows.

Sensory-Perceptual-Motor Programs

The idea of providing sensorimotor experiences has been established primarily through what are called perceptual-motor (P-M) training programs. Historically, in the 1950s and 1960s, P-M programs became prominent. However, their conception and development began in early Greek and Roman civilizations with emphasis on dance and physical fitness.

The act of exploring the role of P-M programs in the public schools began with the works of Delacato (1959), Kephart (1960), and Barsch (1965). All the theoretical models introduced were influenced by the works of Seguin, Montessori, and Strauss (Fleming, 1972). According to Fleming, the strongest theorists and developers of P-M programs were Barsch, Frostig, Kephart, Getman, and Delacato.

Perceptual-motor programs differ from group-oriented, physical education programs due to a more individualized approach. Physical movements are broken down into individual parts, focusing on sensory awareness by working on the child's developmental level. The program teaches the child to monitor and control body positions and movements to derive meaning from sensory experiences.

Commonalities and Differences

Resources from the fields of psychology, medicine, physical education, and physical and occupational therapy have been utilized in developing the framework and procedures for P-M programs. Common components of P-M programs appear to be:

1. Gross motor activities for awareness of body movements.

2. Structured activities for program procedures.

3. Improvement of basic sensory skills (visual, auditory, tactile) as well as motor skills.

4. A relationship of academic skills to the program.

Differences among the P-M programs seem to be the following:

1. Theoretical models upon which Delacato (1959, 1963), Kephart (1960), and Barsch (1965) based their programs.

2. Major emphasis of remediation.

3. Claims designated by specific programs and procedures.

Theoretical Concepts

To understand the goal of Sensory-Perceptual-Motor programs is to know their theoretical constructs. Following are the stronger theorists and developers of such programs.

Robert E. Valett: Psychoeducational program. Valett (1974) has developed a program with 53 prescriptive lessons grouped under six major developmental learning areas:

1. Gross motor development,
2. Sensory-motor integration,
3. Perceptual-motor skills,
4. Language development,
5. Conceptual skills, and
6. Social skills.

The areas most closely related to the study, and to those of Ayres (1979), are gross motor development, sensory-motor integration, and perceptual-motor skills.

The theory outlining this sensory-perceptual-motor approach was founded on the following rationale.

1. Education as a major factor in total human growth and self-actualization.

2. Development of psychomotor, cognitive, and affective skills.

3. Sensory-perceptual-motor skills and integration as significant for symbolic learning.

4. Early identification and analysis of learning and behavioral problems.

5. Individualized and preventative programs for future learning disabilities.

6. Development of self-esteem and self-direction.

Valett's program is designed for prescriptive, individualized intervention and prevention. He has stated that the best approach for implementation of such a program is through conjoint planning of the teacher, administrator, and psychological or educational consultant.

Ray Barsch: A "movigenic" curriculum. This theory explains the child as moving within a self-perceived space; a terrain. Barsch (1967) based his program on 12 dimensions of learning. Key factors in the model are (a) world of space, (b) movement, (c) efficiency, and (d) programmed success.

Barsch developed three dimensions for P-M programs as follows: (a) postural-transport orientation with muscular strength, dynamic balance, and spatial and bodily awareness; (b) percepto-cognitive modes, which include visual and auditory dynamics, kinesthesia, and tactual, gustatory, and olfactory dynamics; and (c) degrees of freedom, which include bilaterality, rhythm, flexibility, motor planning, and temporal awareness.

Newell C. Kephart: Slow Learner Program. The primary basis for the Slow Learner Program is that sensorimotor skills are the foundation on which all learning exists. Kephart (1960) stated that "most of the tasks which we set for the child are complex activities combining many basic sensory motor skills" (p. 33). He placed much emphasis on early motor learning and developmental needs rather than on specific skills.

Kephart's theory is based on hierarchical stages through which the child moves in the environment:

1. Motor stage
2. Motor-perceptual stage
3. Perceptual-motor stage
4. Perceptual stage
5. Perceptual-conceptual stage
6. Conceptual stage
7. Conceptual-perceptual stage

Marianne Frostig. Marianne Frostig (Frostig & Maslow, 1970) is the developer of the Move, Grow, and Learn approach to education. Her P-M program focuses on (a) figure-ground awareness, (b) perceptual consistencies, (c) position-in-space, (d) spatial relationships, and (e) visual-motor coordination.

The child is basically stimulated in a movement program encompassing music, creativity, body awareness, and movement. The purpose of this approach is developing gross motor abilities in these areas: coordination, flexibility, body awareness, balance, agility, creative movement, and strength. Frostig supplemented the movement approach to mental imaging called Pictures and Patterns; using this approach, the teacher reviews the movement program, terminology, and target activities with the child before administering the program. Thus, the child enters the program with a clearer cognitive understanding of what to expect.

Bryant Cratty. Cratty (1969, 1971) supported the theory that movement is an essential and integral element for sensory and intellectual learning. "Integral" is a key word for Cratty's theory, such that movement is not the only means for learning. He accounts for environmental and hereditary factors. He supported the idea that practice of motor skills and perceptual growth develop simultaneously (e.g., tracking a ball and reading).

Cratty (1971) stated:

> Movement will aid thought to the extent that it will teach children to think about their movements. Movement may aid certain perceptual processes to the extent to which we understand the nature of the perceptual process we are attempting to enhance and incorporate movement in this process in intelligent ways. (p. 21)

According to Cratty, the P-M program works to develop facets, particular P-M skills, by various fine and gross motor tasks.

Carl Delacato: Neurologic organization. Delacato's program was based upon the theoretic principle known as neurologic organization. This theory was developed on the biogenetic argument that ontogeny recapitulates phylogeny, meaning that man repeats the patterns of evolutionary development (Delacato, 1959, 1963).

Treatment (remediation) is based on (a) the child's nervous system and (b) neurological development in body movement, and speech, manual, visual, and tactile skills; neurological growth by deprivation, damage, immaturity, and stimulation; and condition of brain functions.

Treatment begins at the level of neurological development at which the child fails. Treatment is a specific prescription program which is methodological and clinical. This includes sensory stimulation (auditory, visual, tactile, thermal), respiration exercises, restricted diet, a reading program, and brain dominance exercises.

Delacato focused on maximum and efficient brain functioning as the impetus for motor learning. However, specific fine and gross motor tasks do not appear to be the focus for remediation or enhancement.

Advantages and Disadvantages

Some educators continue to consider P-M programs only as "remedial" or "habitual" training approaches. According to Fleming (1972), this narrow viewpoint would exclude the normal child from a sound developmental P-M program as designed by Cratty (1970) and Frostig and Maslow (1970). There are advantages and disadvantages of developing P-M programs in a school. The advantages might be as follows:

1. Carefully planned activities to assist the teacher in guiding the child to learn and develop.
2. The teacher capturing the child's intrinsic motivation.
3. Providing physical activity which many schools lack.
4. Organizing and reinforcing learning activities among staff.
5. Cost-effectiveness.
6. Serving both the special and the normal child.
7. Self-awareness.
8. Creativity and pleasure.

9. Adding knowledge from professionally trained teachers in P-M concepts.

10. Bridging the gap between the training of P-M skills as applied to daily classroom needs.

The disadvantages of developing P-M programs in a school might include the following:

1. Failure or lack of direction of P-M programs to inadequate training of teachers to P-M concepts.

2. Misuse of P-M activities due to lack of training.

3. Preplanned activities may create oppositional behavior in the child who may desire a different approach.

4. Remediation may end up the sole focus.

5. Limited trained educators available to assist.

6. Limited focus on auditory and visual-motor skills, with possible disregard of total integration of all sensory capacities.

The common element of sensorimotor and P-M programs and play are sensorimotor pursuits. From sensory-perceptual-motor programs, insight is gained into appropriate motor activities to provide in a quality play curriculum. Again, these programs are offered on the premise that (a) the child is neurologically immature at birth through approximately the first decade of life, and (b) neurological development is primarily aided by sensorimotor play much like that of the programs listed in the review. Actual effects to support this can be seen

in studies using sensorimotor and P-M approaches for enhancement or normalization of normal and special children.

Contributions of Sensory-Perceptual-Motor Programs

Gains from sensorimotor and perceptual-motor programs have already been recognized by researchers in the fields of neurology, neuropsychology, occupational and physical therapy, special education, and education. It has also been recognized that such programs benefit normal and special children depending on the direction and the intensity of approach. These programs operate on the premise that sensory and perceptual stimulation act to organize, reorganize, and strengthen neuronal functions in the central nervous system and, ultimately, in the brain.

Sensory and perceptual-motor programs can benefit the child who needs specific therapeutic intervention. The child who silently goes unrecognized by her less severe sensorimotor needs will benefit by sensory integration opportunities in a natural play environment through a nondirect approach. The normal child benefits in many of the same ways, but especially from enhanced sensory integrative functions. These claims build from the premise that all children are neurologically immature at birth through approximately 10 years of age. Therefore, they operate from basic developmental and survival drives of

hunger, thirst, and sensory-seeking "play" activity (Ayres, 1972, 1979; de Quiros & Schrager, 1978; Ellis & Scholtz, 1978; Montessori, 1964; Umphred, 1985; Valett, 1960).

Sensory-Perceptual-Motor Studies

Research studies on what is abnormal are a vital resource in seeing what is generally normal in human development. The positive effects resulting from sensory and perceptual motor intervention for children with dysfunctions can also be expected to enhance the development of normal children.

Delacato (1966) conducted a study comparing 43 normal kindergarten children in an experimental sensorimotor program to 41 control group children. The experimental program consisted of seven daily sessions (5 to 15 minutes each) of creeping and cross-pattern walking activities, plus two daily sessions (25 minutes each) of listening to nursery rhymes, stories, and songs. The experimental group demonstrated over twice the gain of controls in visual discrimination, attention span, and reading-readiness scores.

In the Journal of Human Movement Studies, a study was reported by Sharpe (1979) involving infant school-children. The study focused on motor development by using movement training to learn successful locomotion. The results were increased discovery attempts and a sense of

independence to initiate mobility for the children. It was stated that the children gained cognitive understanding of their physical world. With clearer understanding, the children demonstrated easier mobility of fine and gross motor tasks.

As cited in Elementary English by Furner (1970), a study was designed using Grades 1 through 3 which emphasized sensory integration with sensorimotor activities for successful motor planning in the skill of handwriting. Children were measured by quality and speed of handwriting in February and June for 3 consecutive years. Findings supported the general conclusion that using multisensory and verbalization procedures to develop a motor ability, handwriting, were effective as a means of instruction.

In a study by Ayres (1974) associating sensory integrative dysfunctions, sensory integrative activities, and learning disorders, the researcher not only found greater gains in academic scores, but also the direct relationship of the remediation treatments of sensory integration therapy to overall achievement.

The theoretical basis of remediation was based on several previous factor analysis results from perceptual, motor, and psycholinguistic tests. An additional factor analysis of scores of the 148 subjects confirmed the presence of five hypothesized syndromes of dysfunction with disorders in (a) postural, ocular, and bilateral

integration; (b) praxis; (c) functions of the left side of the body; (d) form and space perception; and (e) auditory-language function.

The program emphasized normalization of sensory integrative processes, especially at the brain-stem level. Furthermore, it was proposed that carefully selected sensory stimuli and gross motor activities provided opportunities for children to train their abilities to function as a whole unit in sensory and motor modalities.

Valett (1980) described an 8-1/2-year-old female who was brain damaged from an automobile accident. After regaining consciousness from being comatose, she showed loss of speech (aphasia) and reading (alexia). Special education then assessed her as having spatial orientation difficulties, confused laterality, poor postural mechanisms, time disorientation, poor motor planning, and complete loss of visual-auditory decoding skills. These were all regarded as critical sensorimotor integration skills.

The child was prescribed a remedial, developmental sensorimotor program as outlined by Valett (1974) which included (a) target crawling, (b) jumping and rhythm games, (c) symbol-throwing activities, (d) spatial orientation, (e) organization of concrete objects such as wooden symbols, and (f) a series of audio-phonics tasks. Valett (1980) reported improvement in sensorimotor integration. Then the program emphasis changed to more advanced

perceptual-linguistic tasks. The child learned to read and perform academic tasks again, although not on a normal expectancy level.

Sensory and perceptual-motor programs are conducted for enhancement and/or remediation for normal and special children. The level of focus and intensity varies according to the needs of the child and the training of the adult.

Studies from neurology, psychoneurology, and education have contributed insight into the general effects of the transmission of sensory stimuli to neural systems and to the brain. These studies have provided critical information as to theory and approach, from one individual child to many groups of children; from simple to complex remedial approaches to basic guidance of stimulation to public physical education programs. Additionally, these studies have all commonly alerted the public to effective means of intervention for the child with a dysfunction, as well as the normal neurologically immature child at birth, in relation to the critical role of motor activity throughout the first decade of life.

Summary

The review of the literature provides understanding of specific data regarding the role of sensory integration and the brain in the realm of sensorimotor play. Benefits of sensorimotor play were cited through literature from

neuropsychology, sensory integration therapy, and education. Effects of sensory deprivation or sensory integration dysfunction were included to indicate the significance of sensorimotor development. Informal environments such as quality play curriculum,to more formal environments such as sensory-perceptual-motor programs,were reviewed and cited as to their roles and significance to achieving sensorimotor integration.

The corresponding literature supports the fact that an essential ingredient of child's play is the expression of an inner drive toward self-fulfillment as a sensorimotor being. The end product of play, such as a finished sandcastle or perfect balance on a scooter board, is important, but not in and of itself. The significance lies in the capacity to adapt to various sensorimotor processes, thereby mastering sensorimotor challenges as foundational for total human development.

Chapter 3

METHODS

Instrumentation

Descriptive research was conducted in an ethnographic manner. Ethnographic research is defined as research conducted in an established environment with human subjects. Human subjects are only observed to record significant data and are not manipulated in any way. There are no control or experimental groups. Ethnographic data are significant in detecting and recording natural, spontaneous details about certain populations (Cates, 1985).

A sensorimotor checklist was devised by the researcher because no existing instruments could be found that had specific correlations between motor activities in spontaneous play and sensory integration. Instruments available with similar correlations were found in clinical test forms such as The Southern California Sensory Integration Test, by A. Jean Ayres (1971); The Learning Accomplishment Profile, by Anne R. Sanford (1979); the Bruininks-Oseretsky Test of Motor Proficiency, by Robert H. Bruininks (1978); and the Miller Assessment for Preschoolers (1978). However, these tests served as references in developing a sensorimotor checklist when determining which motor activities are most commonly evaluated and treated with sensorimotor

activities and/or sensory integration therapy.

The sensorimotor checklist was developed based on data from Sensorimotor Activities (1977) and Ayres (1972, 1974, 1979). Additional resources included de Quiros and Schrager (1978), Montgomery and Richter (1977), Sinclair (1973), and Young (1980).

Activity analysis information from a sensorimotor symposium in San Diego (Montgomery, 1978) was used as an additional resource for the instrument. This information was significant in that it associated motor activities and sensorimotor functions which correlated to the researcher's instrument.

Furthermore, information was gathered by observations of sensory integration therapy involving children (two 4-year-olds and one 7-year-old) and adults (one 30-year-old and one 60-year-old). Observations took place at three locations in Fresno, California: the occupational therapy department at Fresno Community Hospital, The Learning Development Center, and the physical therapy department at Valley Children's Hospital.

Observations were made between August and December of 1985. The researcher's role in the therapy was strictly observational. When appropriate, the therapist would provide important information regarding the child's current health status, the specific day's therapy, and the direct cause-and-effect relationship of therapy to sensory

integrative functions as therapy occurred. Anecdotal records were taken to record current conditions of the patient, specific fine and gross motor therapy activities prescribed, and any immediate effects of the therapy.

Specifically, the sensorimotor checklist was outlined using information published by the American Occupational Therapy Association (1982) titled Sensory Integration. It was the intention of the researcher to include various quantities of motor activities. A total of 20 fine and 38 gross motor activities were developed from resources which included Ayres (1972, 1974, 1979), Cherry (1976), Montgomery and Richter (1977), Sinclair (1973), Sensorimotor Activities (1977), Young (1980), and Valett (1974, 1980).

Motor activites were then arranged according to established categories in direct correlation with the outlined sensorimotor components (refer to Figure 2 for specific information regarding the sensorimotor checklist instrument). The instrument was further adjusted to 9 fine and 13 gross motor activities after videotaping at Pacific Oaks Children's School. The purpose was to focus on more common activities to which children gravitated. Additional adjustments were made when using the time samples. The purpose was to focus on those activities which were most commonly chosen and repeated by children.

Repeated visits to Fresno Family Day Care and College of the Sequoias Children's Learning Center provided

ACTIVITIES	NEUROMUSCULAR							SENSORY INTEGRATION																			
	F	Motor				St		Sensory Aware						Vis.-Spat.				Body Integration									
		M	C	D				T	PK	O	V	A		F	S	P		B	Po	Bi	Pl	Vm	Mi	Px			
(FINE MOTOR)																											
Cutting																											
Drawing																											
Molding																											
Painting																											
Pasting																											
Pounding																											
Stringing																											
Fitting																											
Pouring																											
(GROSS MOTOR)																											
Balancing																											
Building																											
Climbing																											
Creeping																											
Dancing																											
Hanging																											
Jumping																											
Pedaling																											
Rolling																											
Running																											
Sliding																											
Spinning																											
Swinging																											

Figure 2. Blank sensorimotor components checklist

opportunities in obtaining data regarding repetition and duration. These data directly relate to children's spontaneous play.

According to Ellis and Scholtz (1978), there is a variety of reasons for repetitious behavior. The main reason postulated is a need for activity. Ellis stated that research from Kleitman (1963) and Cofer and Appley (1964) indicated that activity satisfied basic needs. These needs are stimulus-seeking, hunger, thirst, and sex.

Other research by Mackworth (1970) showed spontaneous motor activity to prevent deactivation of the central nervous system. Thus, activity stimulated positive activity of the central nervous system.

Two other attempts explained repetitious behavior as being reward-seeking. Indication was made that activity shifted arousal toward preferred stimulus levels, also reducing levels of anxiety.

Finally, significant to the study were the contributions of Sprague, Werry, and Davis (1969). They postulated that repetitious behavior provided comfortable levels of neural information which involved necessary feedback to the organism for satisfying sensory deficits.

Subjects

Data collection of the subjects was conducted at three early childhood settings. The three locations were Pacific

Oaks Children's School in Pasadena, California; College of the Sequoias Children's Learning Center in Visalia, California; and Fresno Family Day Care in Fresno, California.

Seventy-eight children, ages 2 through 8 years old, were present for videotaping at Pacific Oaks Children's School. The total number of children observed for the time samples was 118. The ages of the children were 3 through 5 years old from College of the Sequoias Children's Learning Center and Fresno Family Day Care. The total number of children observed for the purpose of the study was 179. This included children from all three locations.

Procedures

Research was conducted at three early childhood locations. These centers are recognized for their contributions to the field and for their implementation of play curriculum. The three locations included Pacific Oaks Children's School in Pasadena, California, established in 1945, serving children from infancy through 9 years old; College of the Sequoias Children's Learning Center in Visalia, California, established in 1977, serving children 3 through 5 years old; and Fresno Family Day Care in Fresno, California, established in 1976, serving children 2-1/2 through 5 years old.

Three methods were used for data collection: a videotape, a sensorimotor checklist, and time samples.

Videotaping was accomplished at Pacific Oaks Children's School. The sensorimotor checklist corresponds with the videotape data. The time samples correspond with repeated observations at College of the Sequoias Children's Learning Center and Fresno Family Day Care in detecting repetition and duration of spontaneous motor activities.

Videotaping was employed to collect raw data of children's fine and gross motor activities in the realm of spontaneous play within an established play curriculum. The purpose of the videotape was threefold: (a) to be used with two professionals, who have knowledge of children and sensory integration, for validation of the researcher's interpretations of the correlation between motor activities and sensory integration; (b) to be used as a resource for the researcher in obtaining additional data regarding motor activities and sensory integration; and (c) to be used as future reference for adult education regarding motor activity, spontaneous play, and sensory integration.

The videotape was then viewed by Nikki Trumbo, director of special education at Pacific Oaks Children's School. The researcher requested Ms. Trumbo's interpretations of specific motor activities, in relation to sensorimotor development, as seen in the video. The researcher took note of Ms. Trumbo's interpretations.

The researcher's interpretations were then verbally compared with Ms. Trumbo's. Validation resulted by means

of agreement of the accuracy of the researcher's interpretation to the sensorimotor checklist instrument. This enabled the researcher to mark those areas validated by Ms. Trumbo as matched with those of the researcher.

Ms. Trumbo was able to validate fine and gross motor activities in the motor category and subcategories of the neuromuscular domain, and the visual-spatial category and subcategories in the sensory integration domain.

The fine motor activities focused on were cutting, drawing, molding, painting, pasting, pounding, stringing, fitting, and pouring. The gross motor activities focused on were balancing, building with blocks, climbing, creeping, dancing, hanging, jumping, pedaling, rolling, running, sliding, spinning, and swinging.

Further validation consisted of a meeting, for videotape viewing, with Jane Raschke-Goodman at Valley Children's Hospital in Fresno, California. Ms. Raschke-Goodman is a registered physical therapist certified in sensory integration. However, the videotape was not viewed, as Ms. Raschke-Goodman indicated being able to give interpretations per discussion with the researcher. The researcher took note of Ms. Raschke-Goodman's interpretations.

The researcher's interpretations were then verbally compared to those of Ms. Raschke-Goodman. Validation resulted by means of agreement of the accuracy of the

researcher's interpretations to the sensorimotor checklist. This enabled the researcher to mark those areas validated by Ms. Raschke-Goodman as matched with those of the researcher.

Validation was given for fine and gross motor activities in the neuromuscular domain in all categories and subcategories, and in the sensory integration domain in all categories and subcategories with the exception of the fine motor visual-spatial category. The fine and gross motor activities validated corresponded with those validated by Ms. Trumbo. This enabled the researcher to mark those areas validated by Ms. Raschke-Goodman as matched with those of the researcher.

In addition to validation for the sensorimotor instrument, Ms. Raschke-Goodman suggested the following adjustments to the instrument. Three associations were made between both motor activities and sensorimotor functions which the researcher had not marked. The first included association between climbing and ocular awareness; the second, association of spinning to proprio-kinesthetic awareness; and the third, association of praxis to all motor functions.

Other adjustments consisted of the combining and/or exclusion of particular categories and/or subcategories. The first adjustment was the combining of subcategories

proprioceptive and kinesthetic to "proprio-kinesthetic"; the second, the combining of subcategories postural balance and equilibrium to "postural mechanisms." The third adjustment was the exclusion of both reflex range and praxis categories from the neuromuscular domain; the fourth, the exclusion of haptic, gustatory, and olfactory subcategories of the sensory awareness category; and the fifth, the exclusion of the reciprocal integration and equilibrium subcategories of the body integration category (see Appendix for definition of terms).

The mean for repetition and duration was recorded by time samples. The researcher observed different children for each return visit. Focusing on these variables required the researcher to record the most commonly sought, spontaneous fine and gross motor activities. Fine motor activities recorded were cutting, drawing, fitting, molding, and painting. Gross motor activities recorded were climbing, building, pedaling, running, spinning, and swinging.

Chapter 4

RESULTS

A meeting with the director of special education at Pacific Oaks Children's School in Pasadena, California fulfilled the purpose of validation for the sensorimotor checklist. An additional meeting with a physical therapist, certified in sensory integration at Valley Children's Hospital in Fresno, California, also fulfilled the purpose of validation for the sensorimotor checklist (see Figure 3). (See Table 3 for definitional abbreviations pertaining to the checklist.)

The results of the checklist confirmed direct relationships between fine and gross motor activities and sensorimotor integration components. The checklist also was a means to focus on specific processes between activity and integration.

Time samples collected show results regarding repetition and duration of motor activites in relation to the sensorimotor integrative process. These data were collected at Fresno Family Day Care in Fresno, California, and College of the Sequoias Children's Learning Center in Visalia, California (see Figures 4 and 5).

The mean for duration (in minutes) and repetition for the fine motor time samples is indicated in Table 4. The

ACTIVITIES	NEUROMUSCULAR							SENSORY INTEGRATION																	
	R	Motor				St		Sensory Aware						Vis.-Spat.				Body Integration							
		M	C	D				T	PK	O	V	A		F	S	P		B	Po	Bi	RL	Vm	Mi	Px	
(FINE MOTOR)																									
Cutting		•		•				•	•	•				•							•	•		•	
Drawing		•		•				•	•	•											•	•		•	
Molding		•		•				•		•				•	•					•	•	•	•	•	
Painting		•		•				•		•				•							•	•	•	•	
Pasting		•		•				•		•											•	•	•	•	
Pounding		•		•				•		•		•		•						•	•	•	•	•	
Stringing		•		•				•		•				•	•					•	•	•	•	•	
Fitting		•		•				•		•				•	•					•	•	•	•	•	
Pouring		•		•				•		•		•		•	•					•	•	•	•	•	
(GROSS MOTOR)																									
Balancing		•	•						•	•	•				•	•		•	•	•		•		•	
Building		•	•					•	•	•				•	•					•	•	•	•	•	
Climbing	•	•	•	•		•		•	•	•	•			•		•		•	•	•	•	•		•	
Creeping	•	•	•	•				•	•	•	•					•		•		•	•	•		•	
Dancing	•	•	•			•			•	•	•	•				•		•	•	•	•	•		•	
Hanging	•	•	•						•		•					•		•	•					•	
Jumping	•	•	•			•		•	•		•				•	•		•	•	•		•		•	
Pedaling	•	•	•			•			•	•						•		•	•	•	•	•		•	
Rolling	•	•	•					•	•		•					•		•	•			•	•	•	
Running	•	•	•			•			•	•	•					•		•	•	•	•	•		•	
Sliding	•	•	•					•	•		•			•		•		•	•	•		•		•	
Spinning		•	•					•	•		•					•		•	•					•	
Swinging	•	•	•			•		•	•		•			•		•		•	•	•				•	

Figure 3. Completed sensorimotor components checklist

Table 3. Sensorimotor Components Checklist Definitions

Domain	Category	Subcategory	Definition
Neuromuscular	Range of Motion		Maximum span of joints
	Motor		Overall coordination
		Muscle Control	Directing muscle movement
		Coordination	Gross motor skills
		Dexterity	Fine motor skills
	Strength and Endurance		Muscular strength in time periods for tasks
Sensory Integration			
	Sensory Awareness		Awareness to sensations
		Tactile	Skin contact/pressure
		Proprio-Kinesthetic	Perception of movement, weight, and position
		Ocular	Visual tracking
		Vestibular	Sensory and gravity reception of motion and balance
		Auditory	Identify/interpret sounds
	Visual-Spatial		Perceiving distances between objects and self
		Figure-Ground	Recognize objects among competing stimuli

Table 3 (continued)

Domain	Category	Subcategory	Definition
		Space Perception	Recognize objects as same in different situations
		Position-in-Space	Knowledge of one's position in space in relation to other objects
	Body Integration		Regulating muscle and body part positions
		Body Schema	Self-perception in relation to body parts and environment
		Postural Mechanisms	Developing and maintaining posture, balance, and equilibrium
		Bilateral Motor Integration	Interaction from both sides of the body
		Right/Left Discrimination	Identifying right and left
		Visual-Motor Integration	Combining visual input with voluntary movement
		Midline	Purposeful movement crossing vertical and horizontal midlines of the body
		Praxis	Ability to learn, plan, and execute movement

Source: American Occupational Therapy Association (1982)

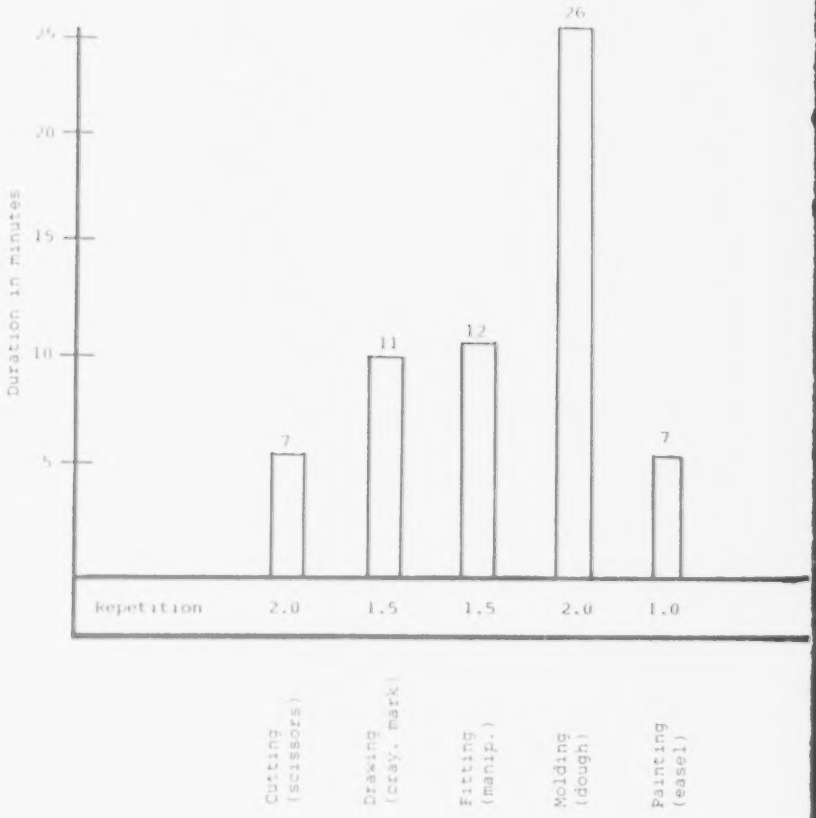

Figure 4. Fine motor time sample

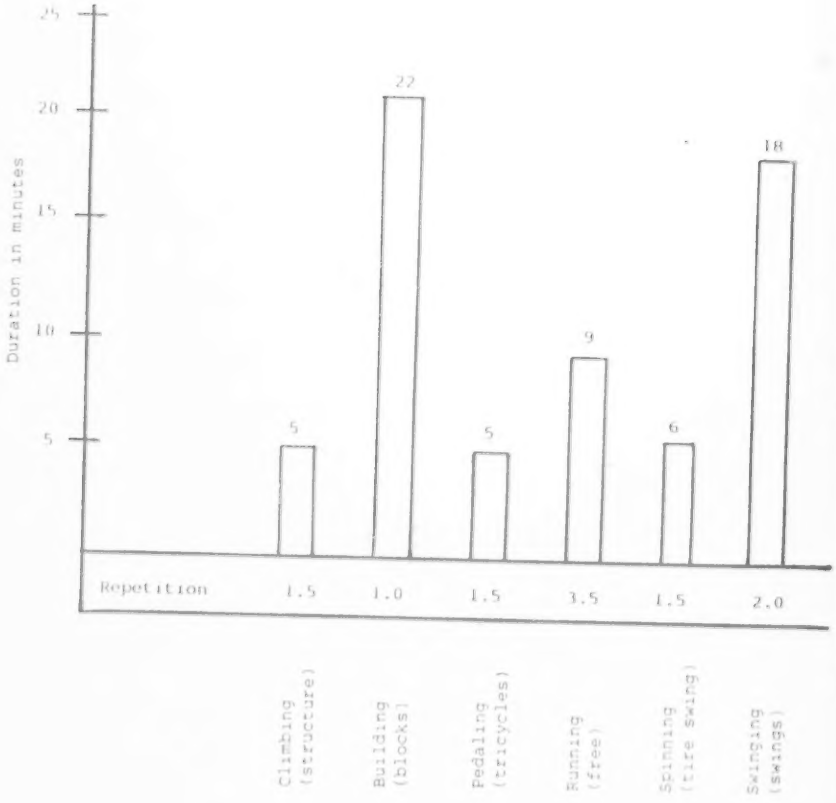

Figure 5. Gross motor time sample

Table 4. Fine Motor Activities

Activity	Duration $\bar{X}$ (Minutes)	Repetition $\bar{X}$
Cutting	7	2.0
Drawing	11	1.5
Fitting	12	1.5
Molding	26	2.0
Painting	7	1.0

Table 5. Gross Motor Activities

Activity	Duration $\bar{X}$ (Minutes)	Repetition $\bar{X}$
Climbing	5	1.5
Building	22	1.0
Pedaling	5	1.5
Running	9	3.5
Spinning	6	1.5
Swinging	18	2.0

mean for duration (in minutes) and repetition for the gross motor time samples is indicated in Table 5.

The duration with the highest mean in fine motor activities was molding, with 26 minutes. The two lowest fine motor activities in duration were cutting and painting, with 7 minutes each. The highest means for repetition in fine motor activities were cutting and molding, with two times each. The lowest fine motor activity for repetition was painting, with one time.

The durations with the highest mean in gross motor activities were building, with 22 minutes, and swinging, with 18 minutes. The lowest fine motor activities in duration were climbing and pedaling, with 5 minutes each. The highest means for repetition in gross motor activities were running, with 3-1/2 times, and swinging, with two times. The lowest gross motor activity for repetition was building, with one time.

Chapter 5

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Discussion

The results of the sensorimotor checklist show direct correlations. These correlations are of fine and gross motor activities to the process of sensorimotor integration (see Figure 3). (See Table 3 for definitions of abbreviations pertaining to the checklist.)

Fine motor activities relate directly to processes in the neuromuscular and sensory integration domains of the sensorimotor component. Specifically, fine motor activities relate to the category "motor" most directly with subcategories muscle control and dexterity.

The category "sensory awareness" most directly relates to subcategories tactile, proprio-kinesthetic, and ocular. It has some relation to auditory awareness. The "visual-spatial awareness" category relates most directly to subcategories figure-ground and space perception. The category "body integration" relates most directly with subcategories bilateral integration, right/left discrimination, visual-motor, midline, and praxis.

The most predominant categories for fine motor activities are "motor" in the neuromuscular domain and "body integration" in the sensory integration domain.

Results show equally significant correlations of fine motor activities in the categories "sensory awareness" and "body integration" in the sensory integraiton domain.

Gross motor activities relate directly to processes in the neuromuscular and sensory integration domains of the sensorimotor integration component. Gross motor activities have direct correlation to the categories "range of motion"; "motor," with emphasis on muscular control and coordination, and some dexterity; and "strength and endurance."

The category "sensory awareness" most directly shows a relationship to tactile, proprio-kinesthetic, ocular, and vestibular subcategories, with some auditory awareness. The category "visual-spatial awareness" most directly relates to figure-ground and position-in-space subcategories, with some space perception. The category "body integration" most directly shows a relationship to the body schema, postural mechanisms, bilateral integration, right/left discrimination, visual-motor, and praxis subcategories, and a partial relationship to the midline subcategory.

The most predominant categories for gross motor are "range of motion," "motor," and "strength and endurance" in the neuromuscular domain. The most predominant categories in the sensory integration domain are "sensory awareness" and "body integration."

Between fine and gross motor activities, gross motor has more direct relationships to the sensorimotor integration component as a whole. Thereby, gross motor activities are proven to be more stimulating and therapeutic for the child.

Time samples of both fine and gross motor activities show correlations of repetition and duration. Spontaneous play opportunities encouraged children to gravitate, repeat, and spend time with those activities which were most stimulating and satisfying (refer to Figures 4 and 5).

Fine motor activities most commonly chosen were cutting, drawing, fitting, molding, and painting. The mean duration among the five activities was 11 minutes, with the mean repetition of 1.5 times. The activities of longest duration were fitting and molding. Molding occurred for as long as 30 to 45 minutes at one time, with a combined time of 45 minutes for some children.

Gross motor activities most commonly chosen were climbing, building, pedaling, running, spinning, and swinging. The mean duration among the six activities was 10 minutes, with a mean repetition of two times. The activities of longest duration were building and swinging. A combined time for swinging occurred for as long as 28 to 36 minutes for some children (refer to Tables 4 and 5).

Limitations to the data could also be as follows: (a) teacher intervention during the child's activity, (b) schedule interruptions, (c) lack of time, (d) distraction, and (e) lack of equipment and opportunity.

The fine motor activities which children gravitated toward were more like those found in perceptual-motor programs which focus on visual-motor skills, and auditory discrimination skills as outlined by Barsch (1965, 1967), Cratty (1970), Delacato (1959, 1963), Frostig and Maslow (1970), Kephart (1960), and Valett (1974, 1980).

The gross motor activities which children gravitated toward were much like those outlined in perceptual-motor programs, but more like those Ayres (1972, 1974, 1979) provided for in sensory integration therapy. They were also more similar to those of Barsch (1965, 1967) and Cratty (1970).

Conclusions

Sensory integration is a natural developmental phenomenon in the normal child. Movement is the vehicle which causes integration to occur. This process is therefore termed "sensorimotor integration." The literature reviewed showed that motor activity during play, more commonly known as sensorimotor play, is stimulus-seeking, possessing an integrative value (Ayres, 1972, 1974, 1979; de Quiros & Schrager, 1978; Ellis, 1973; Ellis & Scholtz, 1978).

Data were collected with the hypothesis that the child provided with ample time and quality play curriculum would experience sensory integration in spontaneous play activities. The data showed that the child will seek, repeat, and spend time in preferred activities.

Therefore, children need to participate in quality play environments. They need to be allowed to participate in those fine and gross motor activities indicated by the sensorimotor checklist. Additionally, the mean duration and repetition of particular activities indicated by the time samples need to be encouraged and regarded daily.

Recommendations

It is the researcher's opinion that society is focusing more now on language, academics, and intellectual development. Less emphasis is placed on sensorimotor foundations. For higher mental functions, the child needs this sensorimotor foundation. The child is spending less time in sandboxes and swings. Kindergarten expects the child to read, not "play." Television inactivates the child. Neither academic nor home environments are providing enough opportunities for tactile, vestibular, and proprio-kinesthetic input. These modalities are the very things that lead the child naturally to the structured activities educators and parents often spend hours coaxing them into. Sensorimotor play is valuable in that it provides the

very input which feeds the brain to begin the learning process.

The young child brings to an early childhood program an abounding sense of curiosity, an intense craving to explore and manipulate the environment, and a biologically programmed drive to move. From the works of Piaget (1952, 1962) comes support that sensorimotor activity serves as the predominant mode for interaction with the environment. This activity is a catalyst for subsequent learning for human development.

Educators must recognize the significance of the physical development of the child. The literature and data demonstrate that sensorimotor integration contributes significantly to overall development.

Sensorimotor integration is one aspect many educators never consider, or overlook. The review of literature provides vital, long-standing information for understanding specific sensory and motor processes. As educators become more sensitive to sensory integrative functions in relation to motor responses, appropriate activities can be planned for and regarded as vital in the day of the child.

In a true play environment, the educator should offer play opportunities which allow for a sensorimotor approach to life. Simply, this means that sensory experiences are integral parts of curriculum, whether fine or gross motor in nature. It is the role of the educator to provide items

which will stimulate, but not overwhelm, all the sensory modalities and thus provide opportunities for channeling motor responses into productive activity.

Time must be allotted to carefully observe the children being served. Specific attention should be made to that which each requests and gravitates toward. Furthermore, one must provide opportunities for requested activities and allow more time and equipment to make this possible.

Reevaluation of the total program is part of this process. How many child-directed activities are included daily? What is the repetition and duration of these activities? Is what the child participates in spontaneous, or is it superimposed and routine?

Educators need to realize that without movement, the child will not fully develop. The child's neurological nature is designed to develop within the first decade of life in the process of sensorimotor integration. Research, including studies regarding sensorimotor deprivation, proves this to be the case.

Realizing all of this, the process of sensorimotor integration can be understood and interpreted more clearly. In addition, problems such as a sensory integrative dysfunction can be recognized. With the child who has some normal childhood clumsiness, yet is aggravated by slight dysfunction, a quality play curriculum is a satisfactory place to be. However, recognition of more

prominent dysfunctions can be extremely vital in referring the child to a professional trained in sensory integration therapy.

The researcher proposes that educators and sensory integration therapists work together. This would be for the benefit of normal and special children who need sensorimotor integration.

The educator needs to take a more medical role in learning about the physiological development of the child. Additionally, training in the field of sensory integration should occur under the direction of physical and occupational therapists. Educators could then work with therapists to provide a positive environment for the child with the dysfunction. Activities from sensory integration techniques could be integrated into educational settings designed from a play curriculum philosophy for the normal child as well. These concepts of sensorimotor integration are not found only in the field of therapy or perceptual-motor programs. They occur naturally in the play environment. These concepts need to be highlighted and built upon in the early childhood setting.

Specialists and therapists could equally benefit from the field of early childhood education. Early educators possess a wealth of knowledge and experience regarding child development. We have been trained in observing and recognizing all differing needs of the child. We are

sensitive to child behavior. As a team, educators and therapists could observe, diagnose, and plan for the whole needs of the child; not only physical, but intellectual, social, and emotional as well.

Educators could train therapists to know and recognize what environments work best outside of the clinic, and outside of perceptual-motor programs. It is the connection between therapy, the school, and the home on which therapists and educators could collaborate.

Educators could advise specialists and therapists as to home prescription activities which enhance therapy and capture the child's innate interests. Advice could be provided as to which academic milestones are appropriate for the child in comparison to those set by diagnostic tools.

Most of all, it is for the benefit of the child that these proposals are given. What type of total, sensorimotor development are we providing for the child? Does the environment work for or against her?

Parents are vital in the sensorimotor development of the child. First sensory experiences are made with the caregiver. From conception, the child is a sensorimotor being. Throughout the school years, the child will demand to move and integrate. Based on the review of literature and collected data, the researcher wants caregivers to acknowledge the very physical needs the child is trying

to communicate. When these needs are acknowledged, there will be better communication between the caregiver and the child.

Parents, watch your child closely. During her play, try to recognize the importance of what she chooses. The joy experienced most likely comes from sensorimotor experiences which develop the brain. Be excited with your child. This will encourage her to encounter various challenges. Dirt and bruises are inevitable in the exploratory stages of play. Support your child's play experiences with actions and words which demonstrate confidence in her attempts. Remember, inner drives cause a play response. If we impose too many other experiences, some benefits may be lost.

With a better understanding of sensorimotor integration, the caregiver can learn to provide for sensory experiences, and to allow them to happen spontaneously. Possibly, if the child has a problem, or a dysfunction, the caregiver can recognize it. From there, the child could be helped by the educator and therapist alike.

Educators and caregivers need to realize that the child does not need prefabricated, complicated, expensive materials and equipment. Most often, the child needs those very activities provided for in spontaneous play, sensory integration therapy, and some sensory-perceptual-motor programs which are often very much alike.

Often the child prefers things available in the environment such as pots and pans, an old bed sheet, or a tire. Play equipment should provide many opportunities to use manipulation, imagination, and creativity without the worry of "using too much," or "breaking something."

Empty cardboard boxes, plastic bottles, tires, inner tubes, pillows, foam pads, sheets, large ropes, and kitchenware could be collected and used from home and community. The child will know what she needs to do and will use them accordingly.

Sandpiles are wonderful. Add cut-up plastic containers, buckets, and shovels. Water and sand are a perfect duo. Shoveling, digging, tunneling, mounding, pounding, sifting, and pouring provide much tactile and proprio-kinesthetic input. Set out trampolines, balance boards, tire swings, large inflatable balls, hammocks, barrels, obstacle courses, bolster swings, and many tricycles. Then watch the child roll, climb, creep, crawl, hop, jump, spin, swing, balance, and pedal.

Enhance already or nearly existing "creative movement" times. Incorporate them throughout the day, using a good resource such as Clare Cherry's (1971) Creative Movement for the Developing Child, which uses the senses and movement patterns in unison. Bring out those records such as "Hap Palmer," "Raffi," and "Steve and Greg." Turn them on and watch how the child responds. Bring out those musical

instruments and large play equipment that are often covered and lying dormant in closets and storage sheds. The very activities and equipment mentioned often are in centers, forgotten or unrecognized.

Finally, play yards are the best resource. Develop and become creative with the normal, standard equipment already at hand. Enhance it with various resources listed above. Too often the first things to be eliminated in the schedule are outdoor and free-movement time. They are squelched by excuses such as, "It's too cold outside" or "We have to make valentines all week." Remember, each time the child encounters sensorimotor play, it benefits her as well as you. These activities provide opportunities for proper investigation and adaptation to physical surroundings.

Most significantly, by allowing for sensorimotor integration within the realm of play, oppositional behavior will diminish. Boredom will become almost nonexistent, and we will have a healthier child. As we understand the deeper sense of the child, childhood will be seen as it is meant to take place.

Given the environment in which to respond, at school, at home, or in specialized programs, we can capture the intrinsic motivation of the child to act upon and learn about the world. This motivation is crucial in all learning aspects.

Actively acquired knowledge is the base upon which learning and adaptation take place. The child's time is best spent in active learning, sensory-acquired experiences. Jean Piaget stated:

> If you spend one year studying something verbally, that requires two years of active study, then you have actually lost a year. If we are willing to lose a bit more time and let the child be active, let him use trial and error on different things, then the time we seem to have lost we may have actually gained. (Hall, 1970, p. 31)

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Adaptive response: A successful response to environmental demands.

Afferent flow: Incoming sensory stimuli to the spinal cord, nervous system, and brain.

Alexia: The inability to understand written or printed symbols.

Aphasia: The partial or complete loss of acquired speech or language.

Auditory awareness: Pertaining to the sense of hearing; identifying and interpreting sounds.

Balance: See equilibrium.

Bilateral motor coordination: The ability to use both sides of the body together for motor responses.

Body integration: Perceiving and regulating position of muscles and body parts in stationary and movement states.

Body schema: The perception of one's own body image.

Cerebral: Pertaining to the brain.

Cerebral cortex: Cerebral tissue on the outermost layer of the brain.

Central nervous system: Pertaining to the nervous system directly concerned with the brain, brain stem, and spinal cord.

Coordination: The use of several muscles for skill and performance. Often referred to as gross motor coordination.

Dexterity: The use of specific, refined muscles for skill and performance. Often referred to as fine motor coordination.

Dysfunction: The disturbance of function.

Efferent flow: Neural impulses carried away from the central nervous system and cell bodies in the cortex.

Equilibrium: The interplay between various forces of gravity, motor power, and skeletal muscles.

Feedback: The arrival at the central nervous system of information from action performed or produced within the individual.

Figure-ground: The ability to recognize forms and objects in configuration with competing stimuli (negative space, moving target, attention).

Fine motor: Small muscle functions such as manipulation, finger tasks, eye-hand/eye-foot coordination.

Function: The special, normal, or proper action of any part or organ.

Gross motor: Large muscle functions such as posture, locomotion, general mobility, and balance.

Gustatory: Pertaining to the sense of taste.

Homeostasis: In physiology, a steady, optimal state of the body by which an organism maintains through feedback controlled by biological activities.

Intersensory integration: The interplay and convergence of all sensory modalities within the brain.

Kinesthetic: An awareness of movement sensations.

Kinesthesia: Conscious awareness of proprioception and movement state.

Learning disorder/disability: Difficulty in learning to read, write, compute, or do schoolwork that cannot be attributed to impaired sight or hearing or to mental retardation. Often referred to as minimal brain dysfunction.

Locomotion: Movement of the body from one place to another.

Midline: An invisible vertical and/or horizontal barrier originated in the brain for developing brain dominance.

Motor: Response of the body to sensory input involving movement or posture.

Motor cortex: The area of the cortex responsible for motor functions.

Muscle control: The ability to direct muscle movement.

Myelin sheath: The fatty substance covering nerve fibers. It serves to increase the speed of nerve impulses along the nerve fibers.

Myelination: The development of the myelin sheath around nerve fibers; allows rapid conduction of sensory and motor information.

Nervous system: Network of nerve cells throughout the body.

Neural: Pertaining to the nervous system; nervous stimuli.

Neuropsychology: The branch of health science which deals with cerebral functions and human behavior.

Ocular control: Pertaining to the eyes; visual tracking and fixation on objects.

Olfactory: Pertaining to the sense of smell.

Ontogeny: The complete developmental history of the individual organism.

Ontogenesis: The process of development.

Perception: The conscious interpretation of sensory input.

Perceptual-motor: Actions using visual or auditory information, motion, and one's perception of the environment in relation to specific skill learning such as putting pegs in a pegboard or following directions.

Phylogeny: The complete developmental history of a race or group.

Physiology: Biological, neurological.

Plasticity: Flexibility; ability to mold, change, and develop.

Position-in-space: Knowledge of one's bodily position in space in relation to other objects or the environment.

Postural mechanisms: The integration of posutre and equilibrium.

Posture: The reflex activity of the body in relation to space.

Praxis: The ability to plan and execute fine and gross motor actions. Learned motor responses.

Proprioception: The sensations from the muscles, tendons, and joints.

Proprio-kinesthetic: The perception of movement, weight, and position. The sense of position and movement of the body. Bodily communication.

Range of motion: The maximum span of joint movement such as stretching and reaching far.

Right/left discrimination: The performance of motor functions on either side of the body without imitation of the other side. The beginning of laterality.

Sensations: Reception of sensory stimuli.

Sensory: Stimulation received by the body and carried toward the brain such as auditory, tactile, visual, vestibular, proprioception, gustatory, and olfactory.

Sensory awareness: Perceiving, interpreting, and differentiating external and internal stimuli.

Sensory deprivation: Too little sensory input received by the brain, or nervous system's inability to process sensory input.

Sensory input: Many afferent electrical impulses flowing from the sense receptors in the body to the spinal cord or brain.

Sensory integration: The organization and adaption of sensory input in the brain for functional use.

Sensory integration dysfunction: An irregularity or disorder in brain functions that causes difficulty to integrate sensory input.

Sensory receptors: Nerve endings or cells which receive incoming stimuli.

Sensorimotor: Using sensory input with motor output for motor functions.

Sensorimotor integration: The act of integrating both sensory and motor impulses in the brain for an adaptive motor response.

Sensory integration therapy: Based on the neurodevelopmental theory of A. Jean Ayres. Involves treatment by occupational and physical therapists by using prescribed sensory stimulating activities to improve cerebral organization and processing of sensations.

Space perception: Recognition of forms and objects as the same in different situations. Pertaining to distance perception.

Strength-and-endurance: Muscular strength in time periods for purposeful tasks.

Tactile awareness: Pertaining to the sense of touch; skin contact and pressure.

Vestibular apparatus: The nonauditory organ(s) of the inner ear dedicated to posture, equilibrium, muscle tone, and orientation in environmental space.

Vestibular awareness: Perception of balance, gravity, posture, and equilibrium to motion.

Visual: Pertaining to sight; seeing.

Visual-motor integration: Combination of visual input with voluntary movement.